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CAPITALIZATION OF LOCAL PROPERTY TAXES AND PUBLIC SERVICES WITH APPLICATIONS TO EFFICIENCY AND EQUITY ISSUES

by

© ANWAR MUHAMMAD CHAUDRY

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled CAPITALIZATION OF LOCAL PROPERTY TAXES AND PUBLIC SERVICES WITH APPLICATIONS TO EFFICIENCY AND EQUITY ISSUES submitted by ANWAR M. CHAUDRY in partial fulfilment of the requirements for the degree of DOCTOR OF PHILOSOPHY in ECONOMICS.

CAPITALIZATION OF LOCAL PROPERTY TAXES AND PUBLIC SERVICES WITH APPLICATIONS TO EFFICIENCY AND EQUITY ISSUES

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ABSTRACT

This study is concerned with the capitalization of local property taxes and public services into housing prices. The Tiebout literature provides the context in which this study approaches and interprets capitalization based on house sales data from the Edmonton metropolitan area. The study presents a comprehensive analysis of both intra- and interjurisdictional capitalization of property taxes and public services. The capitalization of both the effective tax rates and tax payments is examined. The capitalization of public expenditure benefits is estimated using both expenditures and output indicators of public services. Composite indices of local public services are formed in an effort to obtain a better than usual measure of public output. Careful attention is paid to econometric estimation problems. Results employing ordinary least squares (OLS), two stage least squares (TSLS), restricted least squares (RLS), Box-Cox, ridge , and non-linear (NL) regression methods are compared. Problems of simultaneity bias and heteroskedasticity are discussed. The multicollinearity problem is recognized and a possible solution to this problem is presented.

Capitalization results are used to investigate the efficiency and distributional implications of local public goods provision. The net redistributive impact of the local public sector in Edmonton is quantified.

The results indicate complete capitalization of property tax variations using effective tax rate and tax bills both within and across jurisdictions in metropolitan Edmonton and only partial capitalization of local public services lending support to the operation of the demand side of the Tiebout model and the Simon hypothesis. The results further suggest that the Tiebout mechanism does not lead to efficient provision of public services in metropolitan Edmonton. An analysis of the distribution of the capitalized burdens and benefits of the local public sector shows that the overall impact of the local public sector in Edmonton is to redistribute income from the middle class to the poor and the rich homeowners.

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A.M.C.

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1. INTRODUCTION AND LITERATURE SURVEY

1.1 INTRODUCTION

In 1956 Tiebout published a model of local public finance to counter Samuelson's claim (1954,1958) that there was no viable mechanism to reveal individual preferences to ensure optimal provision of public goods. He argued that individual households reveal their preferences for local public goods by seeking out a community of residence that provided a fiscal environment consistent with their demands for local public services. [1] He stated,

> "spatial mobility provides the local public counterpart to the private market's shopping trip. Just as the consumer may be visualized as walking to a private market place to buy his goods,the prices of which are set,we place him in the position of walking to a community where the prices (taxes) of a community services are set" (1956,p.422).

This powerful and prescriptive tool of analysis remained dormant for several years due to a lack of an empirical framework to test the implications of this 'voting with the feet' . Oates (1969) provided the first empirical test of this idea by arguing that if consumers shop among local communities then fiscal differentials among communities will be capitalized into residential property values. [2] This simple idea which is often referred to as the 'capitalization hypothesis' is potentially very powerful for it not only provides a simple measure of individual preferences for local public goods but it also has important implications for equity and efficiency of local public goods provision. [3]

Oates' (1969) study generated tremendous interest in the study of capitalization of property taxes and public services in the U.S. These studies by and large conclude in

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[1] Local public goods are not pure public goods in the Samuelsonian sense and do exhibit congestion costs in the Tiebout formulation. Moreover, the notion of pure public goods breaks down in a setting in which exclusion from the consumption of public services is possible, charges are levied on participants, and an individual household has some range of choice over the public services package in which he participates.

[2] Capitalization represents the discounted present value of a future stream of costs and benefits. Capitalization is most likely to occur in the presence of the following market conditions:

1.consumer knowledge of alternatives in the housing and public sector market;
2.substitutability and comparability of individual properties and neighbourhoods resulting in high cross elasticity of demand among dwelling units and among communities; and
3.relatively inelastic supply of housing in any given community.

See Noto (1976b) p.1. See also Seligman (1927) and Jensen (1931) for further details on the theories of capitalization.

[3] See Brueckner (1979), Starrett(1981), Gramlich and Rubinfeld (1982) and Yinger (1982).

favour of significant capitalization of effective rates of residential property taxes. A Canadian study on the subject by Wales and Wiens (1974) found no evidence of capitalization. [4] This led Bird and Slack (1978) to argue that "it should certainly be possible to do more careful and systemmatic work on property tax capitalization in Canada"(p.143). The present study takes a first step in this direction by investigating the capitalization of property taxes and public services into housing prices and also drawing inferences on the efficiency and equity of local public goods provision in the Edmonton metropolitan region.

1.2 HISTORICAL ROOTS OF THE CAPITALIZATION INQUIRY

1.2.1 Tax Capitalization

Public finance literature has focused attention for some time on the question of whether the local real property tax was shifted forward to the buyer or renter of housing or whether it rested on the seller or landlord. The backward shift phenomenon in which the price offered for property declines in response to the imposition of the property tax is referred to as the capitalization of the tax. [5] Seligman (1927) and Jensen (1931) [6] summarize the conditions under which tax capitalization may take place as follows ;

1. The pattern of future taxes is forseeable and anticipated;
2. The object taxed must be relatively durable in character i.e. it is capable of an annual rental value and has a capital (or stock) value; and
3. The tax must not be capable of being completely shifted.

The extent to which a tax is capitalized depends upon the underlying elasticities of supply and demand in the market for the taxed commodity. [7] Thus there would be no

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[4] A recent Canadian study by Chinloy (1978) finds 51% capitalization (assuming a discount rate of 5% and a 40-year horizon) based on actual tax rates prior to computation of tax credit and 4% capitalization if the effective tax rate net of tax credit is used.See Chinloy (1978),p.749.

[5] See Seligman (1927). Full capitalization would be referred to as a situation whereby a tax causes a change in the price of the taxed good by an amount equal to the capitalized value of the tax (the discounted present value of the stream of costs).

[6] Musgrave and Shoup (1959),p.390

[7] Noto (1976a) illustrates this point graphically. She , however, does not correctly portray the influence of an ad valorem property tax on the demand curve for housing.

capitalization of an ad valorem property tax when there is a completely elastic supply of housing and a demand curve of intermediate elasticity. The tax would be completely capitalized in cases where there is completely inelastic supply curve and an intermediate case demand curve for housing or there is positively sloped supply curve and completely elastic demand curve. Finally there would be partial tax capitalization when there is positively sloped supply curve and negatively sloped demand curve.

1.2.2 Tax and Benefit Capitalization

1.2.2.1 Marshall

Marshall (1948) provided the first insightful but often overlooked discourse on both tax and benefit capitalization. Marshall carefully distinguished between the case of a national property tax and a system of local taxes on property and states that the incidence of local taxes will depend upon ability to migrate and the manner in which the taxes are expended. He contrasts "onerous" (those which yield no compensating benefits) with "remunerative" rates [8] (those which confer benefits on those who pay them) and argues that a person when changing his residence gives full consideration to present and prospective rates in different localities (p.774). [9] He argues that high onerous rates tend "to drive away those persons on whom they would fall", but a "high (remunerative) rate spent on providing good primary and secondary schools may attract artisan residents" (p.794). Marshall recognizes relocation costs and resulting inertia but states that fiscally induced migration "is probably hindered less than is commonly supposed by ignorance and indifference" (p.795).

Marshall argued that only "onerous" rate differentials will be capitalized. The "remunerative" rate differentials on the other hand represent "no real burden" and hence would not affect property values. Thus in Marshall's analysis incidence of rate differentials does not depend on factor mobility but upon the manner in which revenues are expended. Marshall , however, does not believe permanent inequalities of onerous rates would persist. These inequalities he believes would be rectified by administrative

[8] Remunerative rates are levied "to supply the people who pay the rates with certain necessities, comforts and luxuries of life which can be provided by the local authority more cheaply than in any other ways." (Marshall 1948, p.794)

[9] Marshall recognizes that any given rate may be viewed as "onerous" by some and "remunerative" by others.

reform or a change in elected officials (p.798). [10]

1.2.2.2 Tiebout

Although Marshall was the first to recognize both the tax costs and public services benefits of the local public sector, it was Tiebout's (1956) pioneering theoretical work which stimulated major interest in this area. Musgrave argued that Samuelson–Bowen condition for optimal provision of public goods might be impossible to achieve in practice due to preference revelation problem for public goods. Individual may have an incentive to understate their preferences and become "free riders". Tiebout offered a model which contained a market analogue and suggested at least at a theoretical level "that the Musgrave–Samuelson analysis which is valid for federal expenditures, need not apply to local expenditures" (Tiebout 1956,p.416). His "voting with the feet" model is sketched below:

Basic Assumptions :

1. Consumer–voters are fully mobile and have full knowledge of differences among local governments in revenue and expenditure patterns and react to these differences by moving to that community which best satisfies their preference patterns.
2. There are a large number of communities offering a wide variety of choice of expenditure–tax mixes.
3. The public services supplied exhibit no external economies or diseconomies between communities.
4. For every pattern of community services there is an optimal community size.This optimal is defined in terms of the number of residents for which this bundle of services can be produced at the lowest average cost.
5. Those communities below the optimum size seek to expand by attracting residents, and vice versa.

Given the above assumptions Tiebout postulated that individual preferences for local public goods are revealed as individuals exercise their choice of residential location

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[10] Schlack (1977) discusses Marshall, Tiebout and Oates ideas in some detail. See also Ross (1976).

in a community satisfying their taste requirements. "The consumer-voter may be viewed as picking that community which best satisfied his preference pattern for public goods" (Tiebout 1956,p.418). Consumer mobility is crucial in presenting a market analogue as Tiebout writes:

> "The act of moving or failing to move is crucial. Moving or failing to move replaces the usual market test of willingness to buy a good and reveals the consumer -voter's demand for public goods. Thus each locality has a revenue and expenditure pattern that reflects the desires of its residents" (Tiebout 1956,p.420).

What are the implications of the above for the allocation of public goods at the local level? Tiebout elaborates that:

> "Each city manager now has a certain demand for local public goods. In supplying these goods...city manager may be considered as going to a national market and bidding for the appropriate units of service of each kind...The demand for each of the n commoditities will be the sum of demands of the m communites. In the limit ...this total demand will approximate the demand that represent the true preferences of the consumer-voters,that is,the demand they would reveal, if they were forced, somehow to state their true preferences" (Tiebout 1956,p.420).

Thus a consumer confronts basically the same situation in this public goods market that he confronts in a private goods market. Since private goods markets are known to achieve Pareto optimal allocations under certain circumstances Tiebout argued that public goods markets will have the same trait. This argument by analogy contrasts with the Samuelson's conclusion that a public economy could not achieve efficiency in provision of public goods. Tiebout's model's predictive and prescriptive abilities are, however, clouded by its special and abstract assumptions. In particular, the pure model assumes costless mobility induced solely by fiscal considerations, a continuum of jurisdictions and availability of access to each jurisdiction at a tax price equal to the cost of servicing the marginal consumer. [11] . Tiebout further assumes that local public goods crowd with

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[11] See Oates (1981) p.93. It may also be noted that in the Tiebout model expenditure and tax patterns are absolutely fixed "according to the preferences of the older residents of the community" (Tiebout 1956, p.419). Tiebout states "In this model there is no attempt on the part of local governments to 'adapt to' the preferences of cosumer voters . Instead those local governments that attract the optimum number of residents may be viewed as being 'adopted by' the economic system." (p.420)

[12] Rufolo (1979) shows that the Tiebout efficiency results do not emerge when public goods crowd with respect to both property and people. He concludes that the Tiebout hypothesis may only be relevant for some subset of local public goods and it might be preferable to have seperate jurisdictions provide goods which crowd with respect to people .

respect to property only. [12] Tiebout is also silent on the methods of local taxation. [13] His ideas are more consistent with sole reliance on user fees whereas real property taxation figures prominently in local revenue sources in practice. [14] Tiebout also conveniently ignores real world complications such as choices as to owning or renting, non-residential tax base and intergovernmental grants, etc. Even if Tiebout's patently unrealistic assumptions are ignored, recent literature shows that efficient provision of local public goods in a system of local governments is not attainable by "voting with the feet" alone but depends in addition on the much less reliable political process of actual voting. [15] In fact some recent writers have gone so far as to suggest that fiscally induced migration is not so much a solution to one problem (allocative efficiency) as it is the source of many other difficulties. [16] We have presented Tiebout ideas in some detail to transcend the confusion of later studies as to what Tiebout really meant. It may be noted that Tiebout's contribution has two facets. On the demand side he emphasizes that consumers shop around to find a community consistent with their local public sector preferences resulting in allocative efficiency of local public goods. [17] On the supply side his assumptions regarding large number of communities is designed to obtain a solution which "approximates the ideal market solution" (Tiebout 1956,p.421) i.e. the provision of local public goods will be efficient. Tiebout sums up his insights as follows:

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[13] Starrett (1980) investigates the impact of alternate systems of local taxation upon provision of local public goods. He uses a model with Nash type jurisdictional competition and shows that communities will have a bias towards over or underproduction of local public goods depending upon the nature of taxation. He demonstrates that communities restricted to the use of property taxation on a fixed base will try to be more exclusive than is first best optimal and will 'underprovide' where as communities having access to alternate sources of revenue will have incentive to overexpand and overprovide public goods relative to the first best optimum.

[14] Hamilton (1975a, 1975b) demonstrates that Tiebout's ideas can be embodied in a model in which localities make use of property taxation and of a zoning ordinance that specifies a minimum level of housing consumption. This results not only in a stable solution but also a solution in which the property tax becomes a perfect benefit tax , generating no deadweight loss, and in which the efficiency properties of the Tiebout model are reestablished. But this model stretches reality a bit too far by assuming that communities are homogenous both in demands for local services and housing consumption.

[15] See Epple and Zelenitz (1981b) and Yinger (1981,1982). More on this in Section 1.3.

[16] See Miller and Tabb (1973) who conclude that the tendency towards equilibrium in the market for residential choice through the "optimizing " movements of consumer-voters creates a disequilibrium often called as the "urban crisis" (p.173). See also Buchanan and Goetz (1972) and Flatters, Henderson and Mieszkowski (1974) who argue that free mobility will not generate a Tiebout optimum. They reason that migration mechanism creates distortions because migrants ignore fiscal externalities in the communities they leave and enter. Their results are based on models which explicitly restrict the range of choice available to consumers and hence are not very relevant to the Tiebout hypothesis.

[17] See Oates (1981).

> "There is no way in which the consumer can avoid revealing his preferences in a spatial economy" (1956,p.422).

1.2.2.3 Oates

Does the Tiebout model have any practical application? This question remained unanswered until in 1969 Oates developed an empirical framework to test whether or not the local public sector in the real world had any "Tiebout-like" resemblance in its structure and operations. Oates (1969) reasoned that in a Tiebout environment local public services and taxes will be capitalized into residential property values. His empirical findings confirmed such a result which Oates interpreted as confirming the "Tiebout hypothesis" . [11] Oates explained this hypothesis as follow:

> "Tiebout's world is one in which consumer shops among communities offering varying packages of local public services and selects as a residence the community which offers the tax-expenditure program best suited to his tastes" (pp.957-58).

Given this simple (partial) version of Tiebout's model its real world application depends upon establishing that consumer mobility does exist. Oates suggests that:

> "...with the growing urbanization of society, there is some reason to believe that Tiebout hypothesis may be relevant to the real world : individuals working in a central city frequently have a wide choice of suburban communities in which to reside, and the quality of the local public school, for instance may be of real importance in the choice of a community of residence" (p.958).

Oates advocated the following approach to verify the empirical relevance of the Tiebout hypothesis:

> "If this is true (if the Tiebout hypothesis is relevant to the real world), the output of public services (as well as taxes) should influence the attraction of a community to potential residents and should thereby affect local property values" (p.958).

Thus this hypothesis could be verified by observing the capitalization of differentials in fiscal variables into property values. Oates writes:

> "It is the present value of future stream of benefits from public services relative to present value of future tax payments that is in this case important. If consumers in their choice of localities of residence, do consider the available program of public services, we would expect to find that other things equal (including tax rates), gross rents(actual or imputed) and, therefore, property values would be higher in a community the more attractive its package of public goods. Individual families desiring to consume higher levels of public output would presumably tend to bid up property values in communities with higher quality program of public services" (p.959).

Consequently, the housing prices in communities with generous public goods menu and

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[11] Oates (1969, 1973) advanced this interpretation of his results but he later (1981) retracted from this position somewhat by stating that such a test provides some support for the operation of the "demand side" of the Tiebout model.

low local taxes will reflect those advantages. Similarly housing prices in communities not so favourably endowed will bear evidence of that fact.

According to Oates a community's public spending and the taxing activities will affect the market value of residential properties within the community's boundries. He hypothesized that public expenditure exercises a positive and taxes a negative influence on housing values. The net outcome of these two opposing influences constitutes the public sector impact on community property values.

We will see in section 1.3 of this chapter that what Oates claims to be a test of the Tiebout hypothesis is merely a test of the empirical relevance of the Tiebout's postulate on consumer mobility or what Oates now calls a test of the "demand side" of Tiebout model. How did Oates fare in testing even this limited hypothesis? He had a qualified success as the analysis in section 1.4 suggests.

1.3 THEORETICAL UNDERPINNINGS OF THE CAPITALIZATION LITERATURE

The theoretical literature on capitalization focusses on three broad issues. These deal with, (a) formalization of the Tiebout mechanism; (b) empirical tests of the Tiebout hypothesis; and (c) proper interpretation of capitalization. The following subsections present a summary review of these issues.

1.3.1 An Overview Of Theoretical Models

Since Oates'(1969) pioneering study, empirical work addressing the capitalization question has been rich and varied but, until recently, theoretical underpinnings of these studies were not carefully elucidated leading to much controversy over the interpretation of their results. What is needed is a consistent framework yielding unambiguous predictions that are amenable to testing by cross-section regressions of the usual variety. Economists have just begun to address this issue. Various recent attempts to formalize the Tiebout mechanism could be broadly classified into the following five categories.

1. 'Voting with the feet' models.
2. Models of 'voting by ballots'.
3. Integration of 'voting with feet' and 'voting by ballots' approaches.

4. Models investigating the existence and stability of equilibria.

5. Property value determination models.

An overview of these approaches is presented below :

1.3.1.1 "Voting With The Feet" Models

Edel and Sclar (1974), Pauly (1976) and Epple,Zelenitz and Visscher (1978) work could be loosely classified in this category. These models combine consumers' utility maximizing and developers' profit maximizing behaviour in a system of local governments. These authors argue that capitalization represents a disequilibrium phenomenon and would disappear in the long run as housing suppliers respond to price differentials that capitalization implies and consumer preferences are perfectly matched with local public goods consumption opportunities. Starrett (1980) Yinger (1981) and Epple and Zelenitz (1981) argue that the no capitalization conclusions critically depend on the assumptions of no internal spatial structure of communities and that boundaries of communities can be costlessly redrawn.

1.3.1.2 Models Of "Voting By Ballots"

These models focus on the political institutions for decision making in a more direct quest for a demand revealing process. Niskanen (1975), Romer and Rosenthal (1978) and Spencer (1980) have incorporated collective choice mechanisms in formal models. These models touch on Tiebout's work while testing theoretically derived hypothesis using local government data. A general conclusion of this line of research is that collective decision making mechanisms may not ensure the electorate's welfare maximization due to different goals of citizens and their governmental agents. These models do not explicitly incorporate interjurisdictional competition and are thus of limited use in this inquiry.

1.3.1.3 Integration Of "Voting With The Feet" And "Voting By Ballots" Approaches

Although there is a great deal of diversity in the approaches of Edelson (1976) Sonstellie and Portney (1978), Rose-Ackerman (1979), Wildasin (1979), Bucovetsky (1981), Epple and Zelenitz (1981b) and Yinger (1981), their work focused on merging the

two types of voting. [19] These authors, excepting Rose–Ackerman, reach the same conclusions relating efficiency of local public goods provision in a system of local governments i.e. voting behaviour is determinate and leads to a Lindahl type solution in a way that appears consistent with Tiebout equilibrium. However, 'voting with the feet' alone does not ensure this result. It must be augmented by rational intrajurisdictional voting behaviour. Thus Tiebout does need politics.

These models also confirm that the net benefits of the public sector will be capitalized into property values when individuals are costlessly mobile among jurisdictions, have complete information concerning fiscal environments in alternate jurisdictions, jurisdictions do not restrict residents' consumption bundles and jurisdictional boundaries are fixed exogenously.

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[19] Individual summaries of a few selected models are presented below:
Rose-Ackerman (1979) explicitly incorporated household behaviour, the operation of metropolitan land market , the tax expenditure choices open to local government and local political process in a model involving very restrictive assumptions of a single public service whose total cost was independent of town's population and area and residential taxable property being the only source of revenue. She shows that a stable equilibrium in a multigovernment region would not exist and the formation of a metropolitan government with uniform service levels would be a Pareto superior move .
Rose–Ackerman's peculiar results are derived from very restrictive assumptions and ,therefore, are of limited help in understanding Tiebout mechanism.
Wildasin (1979) presents a Koopmans–Beckman–Gale location assignment model and shows that under certain conditions property values will measure the marginal net benefit of local public goods and that the politico–economic process produces an equilibrium in which marginal benefits and tax price are equated for every individual . His results are, however, based on very strong assumtions of

1. the cost of public provision is assumed not to vary with local population and;
2. the tax base of each community is fixed;
3. all dwelling units are identical to one another (equally priced) and are equally taxed;
4. continuum of communities.

Given the above assumptions residents act as price takers and vote for a level of public goods provision which most enhances the value of its initial property holdings. Since property in a given community is homogenous , all households seek to maximize the same price and hence they will be unanimous in their demands. Thus he concludes that voting behaviour is determinate and leads to a Lindahl type solution in a way that seems consistent with Tiebout equilibrium. He further states "exclusive reliance on voting with feet does not produce the Tiebout result: the model has to be augmented with a political theory of public expenditure determination " (p.522).
Bucovetsky (1981) postulates a model of the Tiebout variety and shows that sustainable equilibrium would obtain provided voters always choose efficient public output levels. Thus he shows that the possibility of efficient public provision of output in a system of local governments rests with rational intrajurisdictional voting behaviour rather than with mobility.
Epple and Zelenitz (1981b) investigate the properties of a Tiebout equilibrium assuming local governments act to maximize their profits. They establish that jurisdictional competition is not sufficient to generate public sector efficiency. Mobility of residents across a large number of jurisdictions can prevent individual governments from exploiting the elasticity of housing demand but not the elasticity of housing supply since land is immobile. Thus Tiebout does need politics.

1.3.1.4 Models Investigating The Existence And Stability Of Equilibria

Frank Westhoff(1977,1979) has made important contributions in this respect. He proves existence of equilibrium in a model (1977) allowing interjurisdictional mobility and in which median voter determines the tax rate and public service levels within each jurisdiction. His model, however, has little empirical relevance as it assumes that revenues are raised by a tax on endowments and there is no market for land. In a subsequent article (1979) he postulates an alternative model in which there are fixed number of communities, local government revenues are raised by a proportional income tax and increasing returns to scale in the only public good provided are not exhausted. He proves that under such conditions a stable equilibrium may not exist. Again his model excludes land market. Due to very unrealistic assumptions his model is not very helpful in testing the applicability of Tiebout's welfare propositions to real world situations.

1.3.1.5 Property Value Determination Models Incorporating Local Government Budget Constraint and Voting Process

Perhaps the most satisfactory and satisfying approach to the problem is to transcend the confusion of the Tiebout literature by abandoning the Tiebout hypothesis and focusing on the efficiency question in a world which is not in Tiebout equilibrium. Brueckner (1979,1982) follows this route and postulates a theoretical model of property value determination which yields an estimating equation that can indicate whether or not public goods are provided efficiently even in heterogenous communities (1979,p.224). He (1982) establishes the theoretical result that in a non-Tiebout world, aggregate property values of a community are an inverted U-shaped function of its public goods output. Thus he provides the first consistent empirical framework for investigating the public goods efficiency question.

Yinger (1982) presents the most complete theoretical analysis of capitalization. He integrates the voting process in a model of property value determination. He demonstrates that capitalization is a characteristic of long run equilibrium and is not eliminated by supply responses . He further shows that mobility alone cannot generate an efficient system of local governments because the distortions introduced by property taxes and heterogeneity would still remain. Only if residents always vote for the efficient level of services, then mobility would be consistent with efficiency (p.937). Thus

"efficiency depends on the political process of voting , not just on the market process of choosing a community" (p.938).

The next section summarizes the debate on appropriate tests of the Tiebout hypothesis.

1.3.2 Empirical Tests Of The Tiebout Hypothesis

Since Oates (1969) classic paper there have been numerous attempts to test the Tiebout hypothesis. Empirical tests of this hypothesis were done either using a capitalization approach or a migration model. The two approaches are summarized below .

1.3.2.1 Capitalization As A Test Of The Tiebout Hypothesis : A Summary Of The Debate

We earlier noted that Oates (1969, 1973) in proposing his test of the Tiebout hypothesis (i.e. voting with feet in a multijurisdiction environment leads to Pareto-optimal provision of local public goods) reasoned that fiscal differentials would be capitalized in housing prices in the Tiebout world. Edel and Sclar (1974), Hamilton (1976b), Pauly (1976), Meadows (1976) [20] and Epple, Zelenitz and Visscher (1978) among others on the other hand have argued that in a full Tiebout equilibrium public sector variables will be uncorrelated with housing prices. These latter group of authors assume perfectly elastic supply of local communities such that in the long run consumer preference would be exactly matched with the public goods consumption opportunities. The benefits from higher levels of services would be precisely offset by higher taxes. Consequently there would be equal rents across all communities and capitalization will not occur in "Tiebout equilibrium ". They suggest that the existence of capitalization depends on "an imperfect matching of individual preferences and public goods consumption opportunities" (Pauly 1976,p.239).

More recent literature on this topic has attempted to reconcile these opposing

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[20] Meadows (1976) suggests that a simultaneous equations model approach be used in testing empirically the Tiebout hypothesis. He also thinks this test requires more elaborate data base containing actual sales data and detailed characteristics of individual units and their neighbourhood.

viewpoints.[21] Epple and Zelenitz(1981b) have shown that the capitalization of fiscal differentials is consistent with the view that the consumers "shop" among local communities. We already noted in Section 1.2 that the test proposed by Oates is a test of a Tiebout postulate on consumer mobility i.e. each consumer is free to relocate to maximize his utility. Epple and Zelenitz (1981b) argue that in equilibrium with homogenous residents, the maximum utility individuals can achieve will be the same everywhere. Denote this utility level $\overset{\circ}{U}$.

Setting $U=U(G,P(1+t))=\overset{\circ}{U}$

where G=local public goods

P=housing price.

t=property tax rate

and solving for P, Epple and Zelenitz(1981b) obtain an equation of the form estimated by Oates. [22]

$$P=P(\overset{\circ}{U},G,t)$$

Thus Oates interpretation of capitalization is correct in a Tiebout environment of costless mobility among fiscally differentiated jurisdictions with no restriction on consumption opportunities. This result as shown by Epple and Zelenitz (1981b) is independent of the number of jurisdictions and the objectives pursued by individual communities. However the existence of capitalization when jurisdictional boundaries are fixed exogenously merely indicates that consumers "shop" among local communities. It is not a test of the Tiebout hypothesis, which is a normative statement as to the efficent functioning of the local public sector.

Edel and Sclar et al. are more concerned with the supply side of the Tiebout model. Their hypothesis that housing prices must necessarily be equal across jurisdictional boundaries in Tiebout equilibrium obtains when jurisdictional boundaries can be costlessly redrawn [23] and when there is no internal spatial structure of local communities .[24] If however we introduce restrictions on the supply of communities or housing or certain forms of voting behaviour, Yinger (1981,1982) shows that regardless

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[21] See Starrett (1981,1982), Boadway (1982), Yinger (1981), Oates (1981) and Epple and Zelenitz (1981a,1981b).
[22] See Epple and Zelenitz (1981b) pp.1212-1213.
[23] Ibid.,p.1213.
[24] See Starrett (1981).

of supply responses capitalization will be a feature of long run equilibrium. [25] However "in these weak versions of the Tiebout model the outcomes are no longer so clearly efficiency enhancing" (Oates 1981, p,94).

Thus we conclude this section with the remarks that capitalization of fiscal variables only implies that consumers shop among competing local jurisdictions but does not offer unambigous inferences as regards the implications of this for efficient provision of local public goods.

1.3.2.2 The Migration Models As An Alternate Approach To Test The Tiebout Hypothesis

Several alternate experiments have been proposed by Cebula(1974,1977,1978) , Reschovsky (1979), Aronson and Schwartz (1973) and Schneider and Logan (1982) among others to test the empirical relevance of the Tiebout hypothesis. Theirs are attempts at modelling migration behaviour. The results of these studies are individually discussed below.

Cebula (1978) examines this hypothesis by investigating a migration model that takes into account not only fiscal and labour market conditions in different areas but also geographic living cost differentials. He separately estimates determinants type equations for both white and non-white migrants. Per capita property taxes and public education spending per full time student appear as independent variables. He finds that whereas whites were sensitive to both the property tax level and public educational spending, non-whites were sensitive only to the latter variable. [26]

Reschovsky (1979) analyzes the determinants of residential choice by looking at household moving behaviour. By using data on the number of in-migrants to a set of suburban communities within the Minneapolis- St. Paul metropolitan area he presents

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[25] See Yinger (1981). Yinger argues that the supply responses alluded to by Edel and Sclar are limited by the oppurtunity costs of converting land from non-residential to residential use. Once all profitable conversions have taken place -that is, once suppliers are in long run equilibrium - all remaining variations in service tax packages will be capitalized into house values. (p.100)

[26] Renas (1980) improves upon his specification by using non-deflated values of the variables. Cebula (1977) and Bloom et al.(1975) using similar approaches find that higher educational expenditures are associated with higher rates of immigration of young families with high education. They interpret these findings to indicate that location decisions of families are affected by fiscal preferences ,thereby, empirically validating the Tiebout hypothesis . See also Mayo (1975). Cebula (1974) and DeJong and Donnelly (1973) also find support for the Tiebout mechanism in that higher welfare expenditures are associated with higher rates of immigration of non-whites across SMSAs.

empirical evidence that local fiscal factors both on the tax side and the expenditure side play a role in households' residential choice decision. He further finds "that fiscal factors play a significant role in residential choice decisions hold in cases where elastic supply conditions for housing lead us to expect close to zero capitalization of these fiscal factors" (p.518).

Aronson and Schwartz (1973) on the other hand develop a model of fiscally induced migration. [27] The model shows how the system of financing local public goods can effect the population distribution among towns in a metropolitan area. An analysis of equilibrium and stability conditions of population distribution shows that any equilibrium is likely to be temporary and unstable.

Schneider and Logan (1982) study suburban community growth of low- and high income population and find that differential fiscal characteristics among communities do not have any relationship to income specific growth rates. However, they find that high-income families do cluster in suburban communities with strong property tax bases to afford greater policy options in choosing service levels and tax rates.

It is clear from the above discussion that even migration models do not offer any real test of the complete Tiebout model. They merely test if would-be migrants consider fiscal variables in their locational choice but offer no insights as to the implications of this behaviour for efficient funtioning of a system of local governments. [28] Brueckner (1979) states that :

> "Measuring changes in the degree of community homogeneity over time would be the proper test of the Tiebout hypothesis; increasing community homogeneity would be evidence of the economy's movement towards an efficient Tiebout equilibrium" (p,224).[29]

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[27] Aronson and Schwartz (1973) argue that local expenditures are of crucial importance in fiscally induced migration of the poor and taxes for the rich families. Jackson (1975) takes an opposing view. See also Bradford and Kelejian (1973) for an econometric analysis of fiscal transfers (local revenues) as a determinant of migration in a metropolitan area.

[28] For a discussion of "exclusionary zoning" and "strategic fiscal behaviour" in a Tiebout world, see Hill (1974); Bradford and Kelejian (1973); Buchanan (1967); Gilmer (1976); Buchanan and Wagner (1977); May (1982); Pack and Pack (1978); Jackson (1975); Rothenberg (1977); Schneider and Logan (1981); and Neiman (1981). These authors argue that strong incentives exist for the rich to exclude the poor from their communities. This strategic behaviour to improve the fiscal climate of the community benefits the rich over the poor perpetuating a system of cumulative inequality.

[29] Two recent articles follow this suggestion and examine the degree of homogeneity of local jurisdictions. See Eberts and Gronberg (1981) and Pack and Pack (1978).

How we interpret capitalization in the light of recent theoretical research is the focus of the following subsection.

1.3.3 Interpretation Of Capitalization

Proper interpretation of the findings on capitalization has turned out to be more complex than originally thought by Oates (1969) but on one issue there appears to have emerged a consensus in recent years. [30] This is that the existence of capitalization of fiscal differentials is consistent with the view that people "shop" among competing local jurisdictions. People thus appear willing to pay more to live in jurisdictions with more desirable level of property taxes and public services.

No clear and unambigous inferences can, however, be made regarding the efficiency of local public goods provision from the observance of capitalization of fiscal variables. Nevertheless, Brueckner (1979,1982) has demonstrated that using strong but reasonable assumptions a capitalization study could be used to investigate the issue of the efficiency of public goods output.

In any case , capitalization does matter in deriving second-best efficiency rules for the provision of local public services. For example, the Atkinson-Stern decision rule[31]

> "...to pick up the level of public goods at which the sum of the marginal benefits from the public good is equal to the marginal cost of the good plus the marginal distortion in the market for the taxed good" (Yinger 1982, p.941).

would be void when the existence of capitalization implies that the housing price is endogenous. Yinger (1982) argues :

> "The provision of local services distorts the housing market not only because the property tax alters household consumption of housing but also because the service-tax package influences the market price of housing and thereby alters household consumption of housing. Hence , capitalization may imply that the decision rule for the optimal level of local services differs significantly from the rule derived by Atkinson and Stern" (p.941).

Thus capitalization estimates provide much needed data required by economists in designing policies to enhance the equity and efficiency of local governments under second-best conditions.

Could we draw any welfare implications from the existence of capitalization? Starrett (1981) has shown that increases in residential property values or rent changes

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[30] See Oates (1981) p.94

[31] See Yinger (1982), pp.940-941.

will in general overstate true net social benefits although they may be a good approximation to community net benefits. This happens because land value capitalization does not internalize fiscal externalities of migration. [32]

1.4 A REVIEW OF THE LEADING EMPIRICAL APPROACHES

Most capitalization studies follow Oates' (1969) approach to determine whether fiscal differentials among communities are capitalized into residential property values. The existence of this capitalization is then viewed as affirmation of the Tiebout hypothesis. Recently King (1977) and Reinhard (1981) while agreeing with the theoretical basis of this approach have raised concerns relating to Oates' specifications of the tax price term.

Recent theoretical literature has also placed a much narrower interpretation on Oates' findings. It is now generally accepted that the presence of a capitalization effect merely indicates that consumers in their location decisions consider public sector differentials and does not carry a verdict on the efficiency of local public goods provision as Oates initially implied. Brueckner (1979,1982) recognizes the possibility of public sector inefficiency due to a failure of the Tiebout mechanism in a formal model and establishes that a properly specified property value regression "contains a hidden verdict on the efficiency of public output in a non-Tiebout world" (1982,p.312) i.e. communities with heterogenous populations. In view of the subsequent focus of our empirical work, both the approaches and results of Oates (1969,1973), King (1977), Reinhard (1981) and Brueckner (1979,1982) are discussed in some detail in the following subsections.

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[32]Starrett (1981) clarifies the capitalization mechanism in a system of local governments by defining two types of capitalization i.e. external and internal . He states that external capitalization is induced by forces between communities (focus of Tiebout literature) and internal capitalization occurs due to existence of internal spatial structure in specialized (or Tiebout) communities. Full external capitalization would occur when there are no income effects or preference differences among communities and mobility is costless. In such a situation it will be impossible to insulate the community from external effects and the resulting migration forces will generate external capitalization (p.322). This contrasts with the Tiebout world which is characterized by preference differences among communities. Hence according to Starrett there will be no external capitalization of small projects in Tiebout communities that are "sufficiently differentiated" . He admits, however, that if there are no costs of moving and a continuum of preference types any project will induce some entry and some capitalization.

1.4.1 Property Tax Capitalization Studies

The hedonic price index approach serves as the foundation for all empirical studies on property tax capitalization. [33] This technique derives its theoretical justification from Lancaster's (1966) treatment of a commodity as a bundle of characteristics. [34] The market paralell to Lancaster's approach is to express the price of a commodity as a function of the value of its component attributes. In tax capitalization studies the price of a house is depicted as a function of the valuation of the various characteristics of the house, namely structure, site, neighbourhood, public services and taxes. This framework lends itself conveniently to multiple regression analysis.

In practice, this empirical procedure has resulted in much controversy and debate in recent years. There is an ongoing debate touching on such diverse issues as the choice of the tax price term (Oates 1969, Wales and Wiens 1974, King 1977, Reinhard 1981), the level of data aggregation (Noto 1976a, Meadows 1976) and other econometric issues that can be encountered in almost any empirical work – namely the choice of appropriate functional form, the simultaneity bias (Oates 1973, Pollakowski 1973, Meadows 1976), heteroskedasticity (Reinhard 1981) and multicollinearity (Anderson 1981) problems and the choice of econometric technique and model (Sonstellie and Portney 1980, Hamilton 1982,1979). [35] By far the most important issue in these debates has been the correct specification of the tax price term. Oates (1969) used effective tax rate (tax/price) as the tax price term in his empirical investigation and until recently most subsequent studies followed suit. King (1977) and Reinhard (1981) have recently argued that the tax effect is incorrectly treated in an Oates–type equation and have advocated an alternate approach using annual property tax payments ($) per household as the tax price term. Oates' seminal work and important contributions of King (1977) and Reinhard (1981) are reviewed in the following paragraphs.

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[33] See Appendix H for an overview of the hedonic approach.
[34] The theoretical basis of this technique is also traced to Adelman and Griliches (1961). See also Griliches (1971) for references on earlier applications.
[35] These issues are discussed at length in our empirical analysis.

1.4.1.1 Effective Tax Rate Capitalization

Oates (1969), arguing that he tested the Tiebout hypothesis that households "vote with their feet", examined 53 residential municipalities in northeastern New Jersey to see how property values varied with local property taxes and the provision of local public goods. The following general formulation formed the basis of his empirical test

$$P = \alpha_0 - \gamma_1 t + \Sigma \beta_i X_i \qquad (1.41)$$

$$\gamma_1 > 0$$

where P represents the sale price of the house, t is the effective tax rate and X represents structural, site and public services characteristics of the property. Adapting (1.41) to the data at hand, Oates specified his model as follows:

$$V = V\,(t, SCHL, DCBD, ROOMS, NEW, Y, POOR) \qquad (1.42)$$

where

V = Median home value by town;

t = The effective tax rate (TAX/V) in percentage form;

TAX = Median property tax bill per household in each town (\$), tV;

SCHL = Annual current expenditue per pupil (\$);

DCBD = The linear distance in miles of the community from Midtown Manhattan (in log form);

ROOMS = Median number of rooms per owner-occupied house;

NEW = Percent of houses built since 1950;

Y = Median family income; and

POOR = Percent of families in the community with an annual income of less than \$3,000.

He regressed log V on Log t, log SCHL, log DCBD, ROOMS, NEW, Y and POOR. Both ordinary least squares (OLS) and the two stage least squares (TSLS) estimates suggest that the higher the effective tax rate (other things held constant) the lower is the value of a typical dwelling unit, and conversely, the larger is expenditure per pupil (his proxy for the output of local government services) the higher is its value. Thus fiscal differentials

among communities seemed to manifest themselves in terms of intercommunity differences in property values. People appeared willing to pay more to live in communities with relatively low tax rates and superior schools – lending support to a model of individual behaviour in which fiscal variables do exert a significant influence on location decision.

Oates' results must be accepted with caution due to the following limitations. [36] First, in his estimating equation structural and site characteristics are inadequately represented. The only structural characteristics included are the median number of rooms and a proxy for the age of the housing stock. Second, his sample consists only of residential communities whereas a household is often confronted between choosing among a central city location and residential and industrial suburbs. Barriers to mobility are expected to be greater in this latter setting. Third, his choice of educational expenditure per pupil (SCHL) as his sole local government variable was inappropiate as it neglects other important public services. Neglecting other service variables present us with the missing variables problem. The left out variables may be correlated with SCHL or the property tax rate variable (t) leading to biased estimate for the latter variable. Fourth, it is not clear that expenditure measures are an appropiate surrogate for local public sector output, i.e. SCHL may be completely inappropiate to measure output of education services.

In a subsequent study Oates(1973) attempted to overcome the third limitation cited above. Oates adds as another independent variable municipal spending per capita in 1960 (in $) on all funtions other than local public schools (MUNC). The addition of MUNC to the equation has two notable effects on the results. First the spending variable is itself significant and exhibits the anticipated sign, which is consistent with the hypothesis that public services other than schools do exert some influence on local property values. Second, the absolute value of the estimated coefficent of the tax variable is increased somewhat. This may reflect the significant positive correlation that exists between t and MUNC, with the result that the omission of MUNC in the earlier paper may have understated the degree of capitalization of the property tax. With employment of TSLS

[36] The instability in the estimated coefficients under different specifications noted in the exchange between Pollakowski (1973) and Oates (1973) is very likely attributable yo the fact that each included variable acts as a proxy for a great many omitted but correlated variables. See King 1977, p.426.

and treating SCHL, t and MUNC as endogenous variables lead coefficients of both t and MUNC to increase in value. Oates claims that whereas the estimated tax coefficient in his earlier paper (i.e, −3.6) suggested the capitalization of roughly two–thirds of tax differentials, the point estimate of the coefficient of t (−5.0) now indicated, for typical values of the variable roughly full capitalization of the property tax differentials across the communities in the sample. [37]

With respect to other limitations cited above Oates does not offer any defence. He acknowledged however, the "real uncertainty...when we extend the analysis to encompass the entire metropolitan area, including the central city". [38]

Oates work stimulated a long series of capitalization studies [39] that have attempted to either improve upon his work by paying more attention to the data and estimation or have merely repeated his experiment in a new setting. In general, most of these studies find signficant capitalization of property taxes and public services with the notable exception of Wales and Wiens (1974) and McMillan and Carlson (1977). [40] Wales and Wiens (1974) advance two possible reasons for this result. First, buyers do not recognize tax price differences. Second, "buyers do not offer to pay more for the advantage of lower tax payments for they do not trust their own judgement on a house in the face of what appears to be abnormally low tax assessment" (p.333). McMillan and Carlson (1977) attribute this result to more elastic supply of land for housing in non–metropolitan communities.

1.4.1.2 An Alternate Approach To Property Tax Capitalization

King (1977) argued that Oates' specification of the tax price term was in error. He stated: "whereas the hypothesis suggests capitalization of the tax *burden* , this (Oates') equation suggests capitalization based upon the tax *rate*" (p.426). He further stated that a spurious correlation which works in favour of accepting the capitalization hypothesis is introduced when the effective tax rate is used as the explanatory variable because the dependent variable appears in the denominator of the effective tax tax rate. Wales and Wiens (1974) had earlier rejected that approach. They argued that if the tax level (rather

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[37] See Oates (1973) p.1006
[38] Ibid.,p.1007
[39] See Appendix I for a summary of these studies.
[40] See also Chinloy (1978).

than the rate) is used as an explanatory variable, then it is very likely that there will be a bias towards rejecting the capitalization hypothesis due to the presence of omitted variables that are positively correlated with both tax level and the house value. [41] King (1977) implicitly recognizes the difficulties associated with introducing the tax bill as a regressor directly into an estimating equation and to overcome this problem suggested that the tax price term be included as part of the dependent variable. King suggested an equation of the following form to estimate property tax capitalization:

$$P - b\,TAX = \alpha_0 + \Sigma\beta_i X_i \qquad (1.43)$$

where P represents the sale price of the house, TAX is the annual property tax bill for the house and X_i represents structural, site and public services characteristics of the property. The parameter b measures the extent to which the property tax bill, TAX (=tP) is capitalized into the property value and "...is constrained to a value selected from the interval (0.1–1.0)" (King 1977, p.429). King suggests that a maximum likelihood estimate of the extent of capitalization can be obtained by varying b over the interval, reestimating, and observing changes in R^2.

Reinhard (1981) suggested two corrections to equation 1.43 . First, he pointed out that the dependent variable should be the total cost of homeownership, i.e. house price inclusive of tax costs. Thus b.TAX should be added to the sales price rather than being subtracted as suggested by King. Second, he noted that

> "King's equation suggests the capitalization of 1 (one) year's tax bill, whereas the hypothesis would suggest the capitalization of the present discounted value of the stream of future tax bills. Thus the term btP (=b.TAX) must be adjusted to reflect the appropriate discount rate, r" (p.1253).

A corrected version of equation 1.3 would thus be as follows:

$$P + (b/r)\,TAX = \alpha_0 + \Sigma\beta_i X_i \qquad (1.44)$$

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[41] King's argument has largely been ignored by recent capitalization studies using disaggregated data.

Reinhard states that iterative procedures to obtain the maximum likelihood estimate of b cannot be legitimately applied to equations 1.43 and 1.44 because

> "The variance in the dependent variable (and, consequently, the amount of variation to be explained by the independent variables) is increasing as b increases, thus imparting a bias towards finding of low levels of capitalization when the level of R^2 is used as the maximum likelihood criterion" (p.1253) .

To facilitate a valid comparison of the level of R^2 (or equivalently of the F statistic) across equations Reinhard reexpresses equation 1.44 as follows:

$$P = (\alpha_0 + \Sigma\beta_i X_i)/(1+(b/r)t) \tag{1.45}$$

where t = TAX/P = effective tax rate

The King-Reinhard approach provides a direct estimate of b/r facilitating computation of the degree of capitalization in a relatively simple and straightforward manner.

Reinhard estimates 1.45 using Oates' data. For an equation containing both local expenditure variables i.e. SCHL and MUNC and assuming a discount rate of 5 percent with a 40-year horizon, he finds 145 percent capitalization of property tax bill. For the same model Oates (1973) and King (1977) estimates had placed tax capitalization at 92 percent and 67 percent respectively. Thus while King contends that Oates' specification results in an overestimation of the extent of property tax capitalization , Reinhard (1981) reaches the opposite conclusion.

The instability in the extent of property tax capitalization noted in the above exchanges is very likely to be attributable to the fact that their models and data do not distinguish within and across jurisdiction effects of tax capitalization. With this correction the two approaches may not show any systemmatic tendency to understate or overstate the extent of property tax capitalization. Our results in chapters 3 and 4 of this study provide support for this view.

1.4.2 An Empirical Test for Allocative Efficiency in the Local Public Sector

Brueckner (1979) develops a theoretical model of property value determination to focus on the local public sector efficiency questions in a world which is not in Tiebout equilibrium. For a community with a mixed tax base, a heterogenous housing stock and within community differences in household income, Brueckner draws the conclusion that whereas a positive relationship between public services and residential property values does not lend itself to unambiguous interpretation, an inverse relationship on the other hand is a definite indicator of overprovision of local public goods beyond optimal levels.

In a subsequent study (1982) he establishes a still stronger result:

> "... that aggregate property value in a community which levies a property tax, is an inverted U-shaped function of its public goods output, with the maximum occuring at the output level which satisfies the Samuelson condition for Pareto-efficiency" (p.311).

This analytical result makes it possible to deduce from a property value regression using cross-section data whether a community provides its public goods in a property-value-maximizing (and hence efficient) fashion.

Brueckner (1979) computed the following regression to empirically implement his model:[42]

P = P (ROOMS,OLDAGE HOUSING, DCBD,SALES,Y,POP, POOR,LOCAL) (1.46)

where OLDAGE HOUSING = % of structures in the community built before 1950.

SALES = 1963 $ value of sales of retail, wholesale and service establishments

POP = Town population

POOR = % of families with income below $3,000

LOCAL = SCHL + MUNC

The above equation may be noted for the absence of a property tax variable as a regressor. Brueckner objects to the inclusion of a tax variable along with expenditure variables in a housing price equation arguing that it renders the estimating equation useless as a predictive tool because it does not incorporate the local government budget constraint. He utilized aggregate data on 53 bedroom communities in New Jersey and estimated the above regressions using the TSLS approach. ROOMS, SALES, OLDAGE

[42] See Brueckner (1979) p.240

HOUSING and LOCAL were treated as endogenous variables. Additional exogenous variables for TSLS estimation were median number of years of schooling for males 25 and over , percent of population enrolled in public schools, population density, percent of employed persons in white collar professions, percent of housing units owner-occupied; percent change in population between 1950 and 1960 and the percentage of residents over five years of age who were living in a different community in 1955. SALES and POOR were insignificant in his TSLS estimation and the latter appeared with a positive coefficient - contrary to a priori expectation . LOCAL was significantly negative at the .025 level. He concluded that non-positive coefficients imply that public goods are overprovided in the sample communities.

Brueckner's empirical work has a number of limitations . First, since he had only one observation for each community , he implicitly assumed that all 53 communities in his sample were identically efficient or inefficient in providing local public goods. Second, his estimation suffers from the omitted variables bias. ROOMS and OLDAGE HOUSING are the only two structure related variables appearing in his equations. Finally, he used aggregate data whereas his theoretical model is more suited to empirical implementation with a disaggregated data set.

His 1982 study uses 1976 data for a sample of Massachusettes communities and estimates the following models:

$$A = A\ (\ SCHLE,\ MUNCE,\ HP,\ LARGE,\ Y,\ MG,\ MFGEMP,\ LOCD\ ) \tag{1.47}$$

$$A = A\ (\ LOCALE,\ HP,\ LARGE,\ Y,\ MG,\ MFGEMP,\ LOCD\ ) \tag{1.48}$$

where A = Aggregate property assessment value (equalized assessment) in \$1,000;

SCHLE = School expenditures (\$1,000);

MUNCE = Municipal expenditures (\$1,000);

LOCALE = MUNCE + SCHLE;

HP = Number of single family dwellings in 1970;

LARGE = Percentage of 1970 housing units which had more than one

bathroom;

Y = Median family income ($);

MG = Municipal grants ($1,000);

LOCD = Location dummy for Boston and its innermost suburbs; and

MFGEMP = Manufacturing employment.

In both OLS and TSLS estimation of above equations, in apparent violation of the model, the coefficients of Y and MG were negative and statistically significant at .05 and .10 level respectively. Leaving the coefficients of MUNCE, SCHLE, LOCALE aside for the moment, the remaining coefficients had the anticipated signs but had relatively low t-ratios. The estimated coefficients of MUNCE, SCHLE and LOCALE were not significantly different from zero at .05 level. Brueckner interprets these results as suggesting :

> "...no evidence of a tendency towards systemmatic over- or underprovision of a composite public good; evidence exists of a tendency towards conditional efficiency under the assumption of a common efficiency bias" (p.328).

Once again Brueckner's empirical analysis is extremely weak for his selected set of regressors are inadequate to represent the complex aggregate property value variable of a community. His results are also highly suspect due to the existence of severe multicollinearity among a subset of the sample variables. The simple pairwise correlations between MUNCE, SCHLE, HP and MG all lie between 0.984 and 0.992. Thus his model violates the Farrar and Glauber (1967) rule which states that simple pairwise correlations should not exceed the coefficient of multiple determination. [43] Furthermore, the estimated coefficients show instability over the two estimated equations. This explains why he got a very high R^2 (=0.97) whereas most of the estimated coefficients have low t-ratios. He acknowledges the severe degree of collinearity in his data but states :

> "Unfortunately, since no remedy exists for the multicollinearity problem, there is no way of evaluating the extent of its influence on the regression results" (p.329).

Maddala (1978,p.189) states that multicollinearity is a serious problem in a regression equation if R^2 is high but the t-ratios for regression coefficients are insignificant. He advises against placing any confidence in such an equation.

We provide a stronger empirical test based on Brueckner's theoretical results in Chapter 4.

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[43] See Judge et al. (1980),p.459.

1.5 STUDY OUTLINE

This study investigates the capitalization of property taxes and public services using data from the Edmonton metropolitan region in Alberta, Canada and draws inferences as to the efficiency and equity of the local public sector in this region. No new theoretical results are presented but insights of several studies are synthesized and used to interpret empirical results. An outline of the remaining chapters follows:

Chapter 2 provides a general introduction to the study area. In addition , it describes in detail the data base. It discusses at length its strengths and weaknesses in the context of its suitability to further our research objectives. The chapter outlines the sample selection procedure and discusses the sample characteristics. It also provides an analysis of the property taxation and assessment data.

Chapter 3 presents an empirical analysis of this data. Following Oates (1969), tax capitalization is investigated using the effective tax rate variable. An application of a generalized functional form to the hedonic price function is also attempted. A possible solution to the multicollinearity problem encountered in this study is presented. It is argued that since our data set indicates some collinearity , it would be preferable to use canonical composite indices in place of the original collinear characteristics subsets in multiple regression analysis to arrive at improved estimates of capitalization. Other solutions to this problem including the ridge regression option is also discussed. The investigation is then carried a step further by estimating the capitalization of both within and across jurisdiction differentials in effective tax rates. Public services capitalization is estimated using both expenditure as well as output measures of public services. Ordinary Least Squares (OLS), Two Stage Least Squares (TSLS), and Box-Cox estimation procedures are used.

Chapter 4 investigates tax capitalization using the tax level variables following suggestions of King (1977) and Reinhard (1981). Both inter- and intra-jurisdictional capitalization of property taxes is estimated. Restricted least squares (RLS) and non-linear estimation methods are employed. Public sector capitalization results are summarized under alternate assumptions as to the discount rate and life of the housing stock and are interpreted in the light of discusssion in Chapter 1. The implications of capitalization for efficient provision of local public goods are drawn using a property value determination

model and a balanced budget analysis.

Chapter 5 investigates the net fiscal incidence of the economic activities of the city government in Edmonton. The capitalization approach is used to determine the distribution of burdens and benefits of the local public sector in Edmonton. Spatial inequalities in the distribution of property taxes and public services within the City of Edmonton are also investigated.

The final chapter (Chapter 6) summarizes the findings in the earlier chapters and concludes with a discussion on the implications of these findings for public policy. Suggestions for future research are also made.

Works cited in the text are referenced following Chapter 6 and several appendices are included at the end of the study.

2. THE DATA

2.1 GENERAL INTRODUCTION OF THE STUDY AREA

This study is based upon data from the City of Edmonton and eight major neighbouring urban centres which have primarily grown as bedroom communities for Edmonton. The area encompassing these sample communities will hereafter be called the Edmonton metropolitan region. This definition is consistent with that of Edmonton Regional Planning Commission which designates an area extending 70 kilometers in all directions from Edmonton as the Edmonton Sub-region (see Map 2.1)[1] The following are the distinguishing features of this area:

1. The City of Edmonton is the dominant urban centre;
2. The City of St. Albert and the Hamlet of Sherwood park in the County of Strathcona serve primarily as residential communities followed by a ring of satellite towns (Fort Saskatchewan, Leduc and Spruce Grove); [2]
3. The following small urban centres also perform predominantly dormitory functions
   a. urban centres with 1977 population of 2000-4000:
      Stony Plain, Devon and Morinville
   b. urban centres with 1977 population below 2,000:
      Calmar, Gibbons, Legal, Thorsby, Beaumont, Bon Accord and New Sarepta.

Due to a lack of adequate housing sales data, urban centres having 1977 population below 2,000 could not be included in the sample. Thus the sample contains two cities (Edmonton and St. Albert) six towns (Devon, Fort Saskatchewan, Leduc, Morinville, Spruce Grove and Stony Plain) and an unincorporated area (the Hamlet of Sherwood Park).

The area studied is unique for it is relatively small in size (about 7,000 square kilometers), open (no barriers to mobility exist) and is served by an excellent roadways network. However, significant differences exist among communities as to local taxes and public services and this presents us with a good setting for studying the capitalization of

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[1] See Edmonton Regional Planning Commission (1977). See also Mackenzie Spencer Associates (1979).
[2] For an indepth but somewhat dated discussion see Edmonton Regional Planning Commission (1971).

Within the Edmonton Sub-region

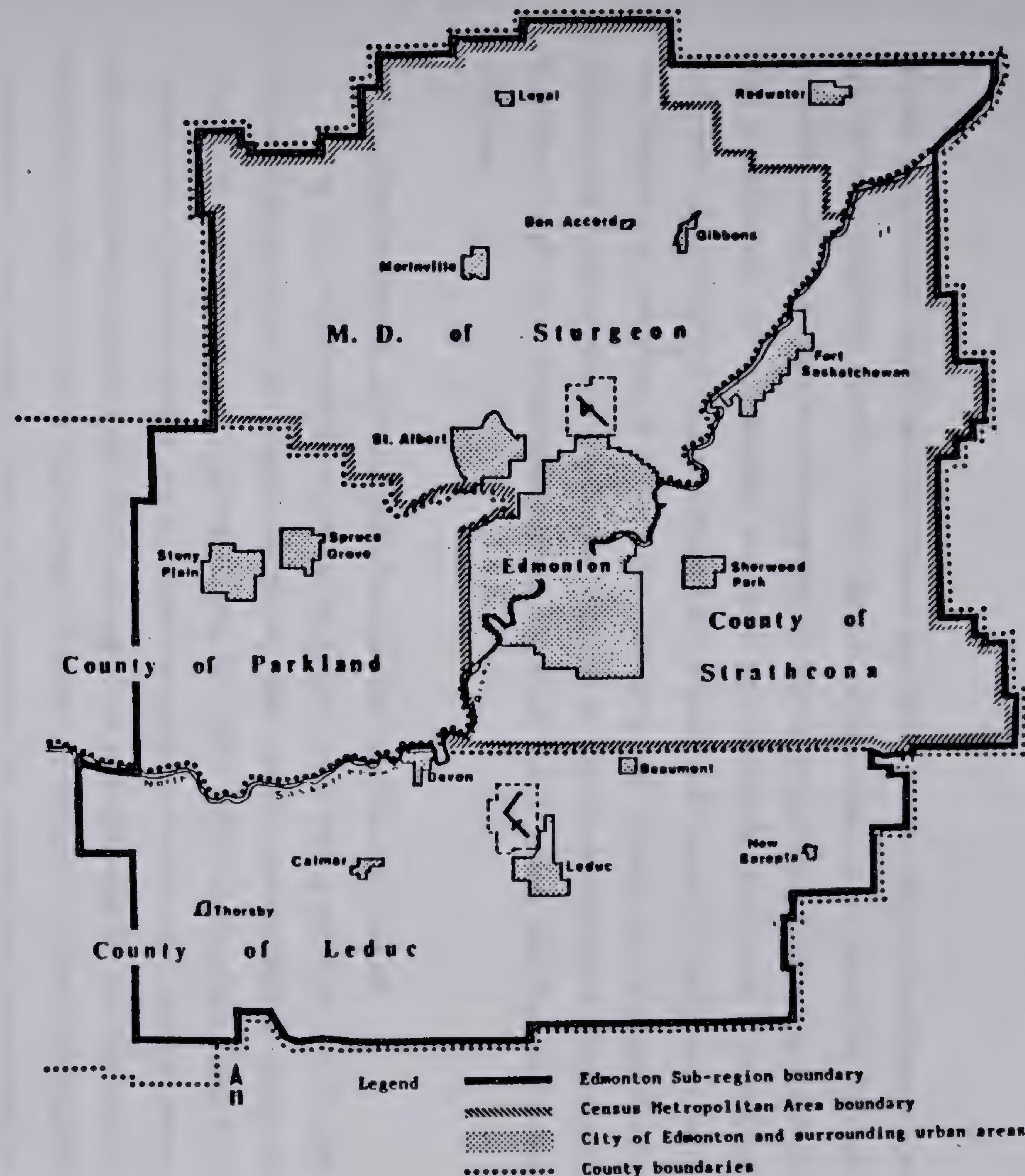
Edmonton Sub-region area: 7,094 square kilometers (2,739 square miles) **City of Edmonton area:** 331 square kilometers (127 square miles)

The area surrounding and including the City of Edmonton has, for the purpose of political administration and research, been officially divided into a number of geographical areas. These are described below:

City of Edmonton - The municipality of Edmonton bounded by the city limits as depicted.

Edmonton Census Metropolitan Area - The metropolitan area of the City of Edmonton as defined by the Dominion Bureau of Statistics, 1971 and Statistics Canada, 1975. The area is comprised of the City of Edmonton and all lands within the County of Strathcona and, with the exception of a recent boundary adjustment, all the lands within the Municipal District of Sturgeon.

Edmonton Sub-region - That portion of the Edmonton hinterland which serves as a labour and housing market area. The area is comprised of the City of Edmonton and all lands within the County of Strathcona and Municipal District of Sturgeon. In addition, the Edmonton Sub-region consists of portions of the Counties of Parkland and Leduc which results in a geographic unit which is more representative than the Census Metropolitan Area with respect to the physical, economic and social interaction within the Edmonton area.



Map 2.1 EDMONTON SUB-REGION

property taxes and public services. (Please see Table 2.1 for data on area, population growth and population density in the sample communities.) Even within the City of Edmonton where interests and lifestyles are so overlapping and integrated as to preclude the establishment of independant municipal administrations, there are nevertheless population groupings into neighbourhoods offering different levels of public services. In the following an overview of basic socio-economic and financial data is presented to highlight the range of choice open to the residents of the region to locate in a community consistent with their preference pattern for local public goods and the associated lifestyles.

2.1.1 Population Growth, Demographic Composition and Housing Tenure

The City of Edmonton dominates the sample areas having 84.6% of 1977 total sample population but has lagged behind all other sample communities in terms of compound rate of population growth during the 1961-1979 period (see Table 2.1). Spruce Grove, Sherwood Park and St. Albert have averaged more than 10% per annum rate of population growth since 1961 compared to approximately 3% for the city of Edmonton. Table 2.2 shows that sample communities differ as to the demographic composition of the population. The city of Edmonton has a much lower percentage of people in the age groups 0 to 19 than other sample communities. There is a great deal of variation among sample communities as to housing tenure as well (see Table 2.3). The City of Edmonton had the lowest (51.1%) whereas the town of Spruce Grove had the highest percentage of owner-occupied private dwellings (91.9%). Observed variations in housing tenure may have implications for public goods provision as owner-occupiers often seem to be more concerned than renters with property oriented public services such as roadways, sewer and water as opposed to people oriented services such as recreation, culture, education etc.

2.1.2 Income and Assessment Patterns

Revenue Canada publishes annually two measures of average income for Alberta municipalities. 'Average income - all returns' is based on all income tax returns filed with the department whereas a second measure 'average income - taxable returns' is based

TABLE 2.1 METRO EDMONTON - POPULATION TRENDS, DENSITY AND AREA

	1961	1977	1979	1979/61 %	Annual Compound Average Pop. Growth	Land Area (Sq. Km)	1977 Population Per Sq. Km.
Edmonton	281,027	471,474	491,359	175	3.15	331.0	1,424
St. Albert	4,059	25,543	28,718	708	11.48	20.62	1,239
Sherwood Park	2.923	26,500	26,496	975	13.03	11.67	2,434
Devon	1,418	2.786	3,475	245	5.11	3.66	761
Fort Saskatchewan	2,972	9.586	10,773	362	7.42	12.51	766
Leduc	2,356	9,128	11,016	468	8.95	13.37	683
Morinville	935	2,198	3,398	363	7.42	4.17	527
Spruce Grove	465	7,137	8,411	1,809	17.45	6.80	1,050
Stony Plain	1,311	3,040	3,884	296	6.22	5.48	555
TOTAL	297,466	557,392	587,312	197	3.85	409.28	1,362

Source: 'Comparative Population List 1976-1980' and 'Municipal Statistics - 1977', Alberta Municipal Affairs.

TABLE 2.2 METRO EDMONTON – AGE STRUCTURE OF POPULATION, 1976

Percentage Distribution of 1976 Population By Age Group

	0–19	20–64	65+
Edmonton	34.76	58.10	7.14
St. Albert	44.84	53.05	2.11
Sherwood Park	47.00	51.44	1.56
Devon	40.04	56.01	3.95
Fort Saskatchewan	41.84	53.58	4.58
Leduc	40.97	53.02	6.01
Morinville	45.34	50.12	4.53
Spruce Grove	45.95	52.31	4.53
Stony Plain	34.19	49.82	15.99

Source: '1976 Census Canada – Population: Demographic Characteristics, Five Year Age Groups'. Statistics Canada, Ottawa Catalogue No. 92–823

TABLE 2.3 METRO EDMONTON – OCCUPIED PRIVATE DWELLINGS BY TENURE – 1976

	TOTAL DWELLINGS	OWNED	RENTAL	% OWNER OCCUPIED
Edmonton	155,490	79,420	76,070	51.1
St. Albert	6,265	5,525	745	88.2
Strathcona	10,920	9,650	1,270	88.4
Devon	815	725	90	89.0
Fort Saskatchewan	2,365	1,685	740	71.2
Leduc	2,500	1,980	520	79.2
Morinville	565	470	95	83.2
Spruce Grove	1,855	1,705	145	91.9
Stony Plain	860	675	180	78.5

Source: '1976 Census of Canada. Census Tracts – Population and Housing Characteristics–Education' Statistics Canada, Ottawa, Catalogue 95-803, November 1978.

on taxable returns data only. These data are presented in Table 2.4. The table shows that the sample communities have discernible differences in average income. Communities with different levels of income are likely to opt for different levels of municipal services.

A comparison of the taxable assessment base offers insights to the fiscal capacity of the sample municipalities. Differences in local assessment practices preclude comparison of actual assessment figures for various municipalities. The provincial government, however, annually estimates the actual market values of the properties for all Alberta municipalities and on this basis calculates equalized assessment figures which are directly comparable. [3] Table 2.4 presents per capita data on equalized assessments and the School Foundation Program (SFP) equalized assessments and also lists what percentage of actual assessment is non-residential. The table highlights significant differences among sample municipalities as to their fiscal capacity (assessment base) and its composition. Strathcona, Edmonton and Fort Saskatchewan appear to have greater potential to raise revenues from own sources by exploiting a non-residential tax base than other sample municipalities which are primarily residential communities.

Table 2.4 may understate the revenue potential of those municipalities which levy business taxes against business assessments (based on a percentage of the estimated market rental of the firm's premises). Business assessment values and business tax rates of such municipalities are presented in Table 2.5.

2.1.3 Patterns of Municipal Expenditures

Alberta municipalities are entrusted with a number of public service delivery responsibilities. Appendix B outlines these functions by financial reporting category. [4] A wide array of these municipal services offered by the sample municipalities cannot be accurately quantified. However, municipal operating expenditure in a particular year does provide an indication of public preferences for the mix and level of public services. Table

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[3]The equalized assessment is the assessment of the municipality adjusted in order that the assessment may be used as a yardstick for cost-sharing programs (e.g. School Foundation Program) and as a factor in calculating provincial assistance grants. As an example, land in an urban municipality is assessed at 65% of the market value during the year previous to assessment . If one municipality was assessed in 1970 and the other in 1975 , the land assessment in the second municipality would be much higher. For equalization purposes all urban land is equalized each year at 20% of market value during the previous year.

[4]See Chaudry (1980a, 1980b), Provincial Municipal Finance Council (1979) and Stamm (1979) for a review of local government finance in Alberta.

TABLE 2.4 1977 ASSESSMENT AND INCOME DATA FOR SAMPLE AREAS

	1977 Equalized Assessment Per Capita ($)	1977 SFP Equalized Assessment+ Per Capita ($)	% Non-Residential* Actual Assessment	1977 Average Income($) All Returns	Taxable Returns Only
Edmonton	3662	1451	32.6	12734	15863
St. Albert	2694	359	5.8	14242	17256
Strathcona	4609	2396	54.2	14653	17723
Devon	3006	966	22.8	13371	16051
Fort Saskatchewan	3278	1489	42.2	13183	16259
Leduc	2784	770	16.6	13085	15871
Morinville	2041	523	16.8	11593	14654
Spruce Grove	2716	636	26.8	13980	16643
Stony Plain	2913	680	14.2	12374	15423
ALL COMMUNITIES	3643	1442	33.0		

+ refers to non-residential and vacant residential land equalized assessment subject to the School Foundation levy.
* refers to commercial/industrial land and buildings, machinery and equipment, pipelines, powerlines and cable TV.
a For Sherwood Park the comparable figure would be 6.2%.

Source: (1) Alberta Municipal Affairs, Assessment Equalization Board
(2) Alberta Treasury, Bureau of Statistics

TABLE 2.5 STUDY AREAS WITH BUSINESS TAXES - BUSINESS AND COMMERCIAL-INDUSTRIAL ASSESSMENTS

	Business Assessment ($)	Business Mill Rate	Commercial/Industrial Buildings & Improvements Assessment * ($)	Business Assessment as % of Commercial/Industrial Assessment
Edmonton	162,449,225	123	623,454,600	26.1
St. Albert	1,016,540	65	2,993,28	34.0
Leduc	2,424,890	12	3,984,530	60.9
Morinville	213,850	20	1,444,420	14.8
Spruce Grove	602,745	53	8,032,180	7.5

* excludes land, pipe and power, CATV, Railway and Machinery and Equipment

Source: 1977 Financial Statements submitted to Alberta Municipal Affairs

2.6 offers the following insights in this respect.

1. The City of Edmonton had the highest per capita municipal operating expenditure in 1977.
2. Edmonton assigns a much lower priority to transportation services (excluding public transit) and higher to police and fire protection than each of the sample municipalities.
3. The smaller urban centres spend a greater percentage of their budgets on recreation and culture and general government compared to the three large urban centres (Edmonton, St. Albert and Sherwood Park) studied.

2.1.4 Patterns of Municipal Revenues

A description of various revenue sources available to Alberta municipalities is presented in an appendix (see Appendix B) to this chapter. Table 2.7 presents 1977 per capita general operating revenues for the sample municipalities. The following general observations are based on this table.

1. Municipal property taxes is the single most important source of municipal revenues.
2. Edmonton, Leduc, Morinville and Spruce Grove derive substantial revenue from frontage charges.
3. Although five sample municipalities levy business taxes, it is only Edmonton which derives significant revenues from this source.
4. For the overall sample the following order of relative importance of various revenue sources is established:

Revenue Source	Rank
Property taxes – Municipal	1
Property taxes for Requisitions	2
Sales of Goods & Services	3
Grants	4
Other revenues from own sources	5
Own Transfers	6
Business Taxes	7
Special Assessments	8

In concluding this section it is interesting to note the policies of the sample municipalities relating to user fees. Table 2.8 presents statistics on environmental health,

TABLE 2.6 STUDY AREA - 1977 PER CAPITA AND PERCENT OF GENERAL OPERATING EXPENDITURES BY FUNCTION

	General Government	Police Protection	Fire Protection	Other Protection	Transport Services	Sewage	Waste
Cities							
Edmonton	37 (5.8)	59 (9.3)	38 (6.0)	8 (1.3)	35 (5.5)	10 (1.6)	19 (3.0)
St. Albert	35 (8.0)	22 (5.0)	16 (3.6)	6 (1.4)	56 (12.8)	10 (2.3)	10 (2.3)
County							
Strathcona (S.P.)	40 (8.0)	13 (2.6)	19 (3.8)	- -	114 (22.9)	4 (0.8)	6 (1.2)
Towns							
Devon	50 (15.2)	18 (5.5)	3 (0.9)	- -	47 (14.3)	20 (6.1)	14 (4.3)
Fort Saskatchewan	43 (13.4)	20 (6.2)	9 (2.8)	4 (1.2)	35 (10.9)	3 (0.9)	10 (3.1)
Leduc	40 (11.9)	20 (5.9)	4 (1.2)	5 (1.5)	44 (13.1)	12 (3.6)	9 (2.7)
Morinville	49 (14.8)	19 (5.7)	9 (2.7)	1 (0.3)	38 (11.4)	16 (4.8)	9 (2.7)
Spruce Grove	45 (12.9)	24 (6.9)	7 (2.0)	1 (0.3)	42 (12.0)	2 (0.6)	9 (2.6)
Stony Plain	48 (12.0)	21 (5.2)	4 (1.0)	3 (0.7)	53 (13.2)	3 (0.7)	17 (4.2)
AVERAGE (weighted) $'s per capita % of TOTAL	37 (7.0)	52 (9.8)	34 (6.4)	7 (1.3)	42 (7.9)	9 (1.7)	17 (3.2)

- indicates less than $1 per capita

TABLE 2.6 (cont.)

	Health & Welfare	Environ. Development	Recreation & Culture	Debt charges	Transfers to own funds	Requisitions*	Public Transit	TOTAL
Cities								
Edmonton	19 (3.0)	7 (1.1)	54 (8.5)	87 (13.7)	42 (6.6)	140 (22.1)	78 (12.3)	633 (100.0)
St. Albert	8 (1.8)	6 (1.4)	34 (7.7)	42 (9.6)	98 (22.3)	65 (14.8)	32 (7.3)	439 (100.0)
County								
Strathcona	6 (1.2)	7 (1.4)	44 (8.8)	33 (6.6)	30 (6.0)	170 (34.1)	13 (2.6)	498 (100.0)
Towns								
Devon	1 (0.3)	- -	46 (14.0)	24 (7.3)	75 (22.9)	30 (9.1)	-	328 (100.0)
Fort Saskatchewan	6 (1.9)	1 (0.3)	40 (12.5)	24 (7.5)	11 (3.4)	117 (36.4)	-	321 (100.0)
Leduc	6 (1.8)	1 (0.3)	42 (12.5)	25 (7.4)	12 (3.6)	123 (36.5)	-	337 (100.0)
Morinville	- -	1 (0.3)	56 (16.9)	40 (12.0)	39 (11.7)	56 (16.9)	-	332 (100.0)
Spruce Grove	- -	- -	51 (14.6)	63 (18.0)	31 (8.9)	75 (21.4)	-	350 (100.0)
Stony Plain	- -	- -	52 (13.0)	59 (14.7)	61 (15.2)	80 (20.0)	-	401 (100.0)
AVERAGE (weighted) $'s per capita % of TOTAL	17 (2.8)	7 (1.2)	51 (8.5)	78 (12.9)	44 (7.3)	136 (22.5)	71 (11.8)	603 (100.0)

\- indicates less than $1 per capita

* These include school, regional health and planning property tax transfers to school hospital and regional planning authorities.

Source: 1977 Financial Statements of Municipalities

TABLE 2.7 STUDY AREA - 1977 PER CAPITA AND PERCENT OF GENERAL OPERATING REVENUES BY SOURCE

	Property Taxes - Municipal[1]	Special Assessments[2]	Business Taxes	Sales Of Goods & Services[3]	Other Revenue From Own Sources[4]	Unconditional Grants	Conditional Grants	Own Transfers	Property Taxes For Requisitions	Total[7]
Cities										
Edmonton	159 (26.0)	21 (3.4)	43 (7.0)	81 (13.3)	55 (9.0)	21 (3.4)	41 (6.7)	51 (8.3)	140 (22.9)	611 (100.0)
St. Albert	155 (37.0)	2 (0.5)	3 (0.7)	46 (11.0)	23 (5.5)	25 (6.0)	21 (5.0)	80 (19.1)	65 (15.5)	419 (100.0)
County										
Strathcona	211 (43.1)	- -	- -	20 (4.1)	43 (8.8)	24 (4.9)	21 (4.3)	- -	170 (34.8)	489 (100.0)
Towns										
Devon	203 (57.7)	- -	- -	29 (8.2)	31 (8.8)	34 (9.7)	25 (7.1)	1 (0.3)	30 (8.5)	352 (100.0)
Fort Saskatchewan	121 (37.1)	2 (0.6)	- -	15 (4.6)	19 (5.8)	34 (10.4)	10 (3.1)	8 (2.5)	117 (35.9)	326 (100.0)
Leduc	113 (27.4)	19 (4.6)	3 (0.7)	24 (5.8)	48 (11.6)	37 (9.0)	18 (4.4)	69 (16.7)	82 (19.9)	413 (100.0)
Morinville	106 (32.2)	22 (6.7)	2 (0.6)	31 (9.4)	20 (6.1)	48 (14.6)	44 (13.4)	- -	56 (17.0)	329 (100.0)
Spruce Grove	125 (35.1)	28 (7.9)	5 (1.4)	31 (8.7)	35 (9.8)	25 (7.0)	27 (7.6)	7 (2.0)	75 (21.1)	356 (100.0)
Stony Plain	171 (41.5)	9 (2.2)	- -	31 (7.5)	60 (14.6)	19 (4.6)	27 (6.6)	15 (3.6)	80 (19.4)	412 (100.0)
AVERAGE (weighted) $'s per capita % of TOTAL	161 (27.9)	18 (3.1)	35 (6.1)	72 (12.5)	51 (8.8)	22 (3.8)	37 (6.4)	47 (8.1)	136 (23.5)	578 (100.0)

Source : Alberta Municipal Affairs.

Footnotes

1 Municipal levy only; includes grants-in-lieu of taxes
2 Local improvement, frontage charges
3 Includes "Services to other Governments", plus sewage, waste disposal ,recreation and public transit charges.
4 Includes mobile unit licenses, other licenses and permits, municipal by-law fines, rents, concessions, franchises, investments, tax penalties and costs
5 Includes transfers from own reserves and allowances, funds and agencies.
6 School, health and regional planning transfers to other local authorities.
7 May not total due to rounding
\- Means less than $1 per capita

recreation water and public transit user charges. No discernible pattern emerges from this analysis but it is clear that sample municipalities do not follow any mutually consistent policies.

2.2 THE SAMPLE

The primary source of our housing data is the Multiple Listing Service (MLS) by the Edmonton Real Estate Board. [5]

2.2.1 Sampling Procedure

A total 18,023 residential properties were sold through the Edmonton Real Estate Board during the period July 1976 to June 1978. Out of these a first stage stratified random sample of 2814 residences sold primarily in the summer of 1977 was drawn. To capture intrajurisdictional variations in the capitalization of property taxes and public services, 137 communities in the City of Edmonton were aggregated into 27 relatively homogenous neighbourhoods based on a factor analysis performed by the City of Edmonton Parks and Recreation Department. [6] Lack of sufficient data precluded carrying out a similar exercise for for any of the eight neighbouring communities in the sample. Thus the sample consists of a total of 35 communities of which 27 were located within the Edmonton city corporate limits. A representative proportional sample constituting 0.8 percent of total single detached plus duplex residences in each area was then drawn. This resulted in the selection of 875 properties, representing 31.1 percent of total residential properties sold during the summer of 1977, to be analyzed in this study. Structural characteristics for the sample properties were obtained from the Multiple Listing Service thanks to the cooperation of Melton Real Estate whereas data on public services were supplemented from other sources. A brief description of variables included in this study follows .

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[5] MLS is an authority granted by an owner to the Edmonton Real Estate Board and all its participating agents to offer for sale, exchange or lease his property on certain terms and conditions set forth in the listing agreement. An MLS listing is always in writing and a specimen of this agreement is included in Appendix D.

[6] See City of Edmonton (1978), Appendix VII, p.41 and pp.20-29. For community maps and names see appendices E and F respectively.

TABLE 2.8 STUDY AREA - 1977, PERCENTAGE OF SEWAGE AND WASTE DISPOSAL, RECREATION , WATER AND PUBLIC TRANSIT EXPENDITURES COVERED BY USER FEES AND OTHER CHARGES

	Sewage & Waste Disposal Charges as % of Sewage & Waste Disposal Operating Expenditures	Recreation Charges as % of Recreation Operating Expend.	Water User Fees as % of Water Operating Expend.	Farebox Revenues as % of Public Transit Operating Expend.
	%	%	%	%
Cities				
Edmonton	65.5	13.4	111.9	49.3
St. Albert	83.7	9.9	81.0	32.9
County				
Strathcona	51.1	6.5	92.2	28.9
Towns				
Devon	50.9	0.0	102.7	-
Fort Saskatchewan	22.5	18.1	87.6	-
Leduc	94.8	6.4	79.7	-
Morinville	120.1	0.0	70.5	-
Spruce Grove	218.0	7.9	65.8	-
Stony Plain	65.2	12.2	70.0	-
AVERAGE	66.7	9.3	106.9	-

Note: Operating Expenditure for Waste Disposal, Sewage and Recreation does not include debt repayment charges for those service facilities. Sewage charges does not include local improvement taxes. Recreation charges does not include revenue classified as "Rentals, Concessions and Franchises" under the Other Revenue from Own Sources category.

Source: Basic data from 1977 Financial Statements submitted to Alberta Municipal Affairs.

2.2.2 Structural Characteristics

The house-specific data on the following structural characteristics were obtained through MLS.

1. Rooms (ROOMS)
2. Number of bedrooms (BROMS)
3. Garage size - in number of stalls (GAR)
4. Lot size in square feet (LSIZE)
5. Dwelling size in square feet (DSIZE)
6. Age in years (AGE)
7. Living room area in square feet (LRA)
8. Dining room area in square feet (DRA)
9. Kitchen area in square feet (KRA)
10. Bedrooms area in square feet (BRA)
11. Recreation and/or family room - A 0-1 dummy variable equal to 1 if the property has a recreation and/or family room (DFR)
12. Number of 3 or 4-piece baths (BATH)
13. Heat - a binary variable equal to one if the house has forced air heating system (FA)
14. Dummy = 1 if house is a duplex (DUP)
15. Dummy = 1 if exterior has a brick or stone finish (BRST)
16. Dummy = 1 if the property is a two storey house (TWO)
17. Dummy = 1 if the property has a fireplace (FP)

2.2.3 Neighbourhood Characteristics

Most of the socio-economic data are available by census tract and the City of Edmonton was subdivided into 90 census tracts for 1976 population census. Therefore, it was necessary to relate each census tract to a particular neighbourhood and then to compute weighted averages for each neighbourhood based on census tract data. This procedure was used to identify total population (POP), median family income (Y) and the number of single family dwellings (HP) for each neighbourhood in this study. [7]

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[7] Population and housing statistics were extracted from Statistics Canada (1978). Median family income was obtained from unpublished community profiles with the Parks and Recreation Department, City of Edmonton.

2.2.4 Locational Variables

Four locational variables are included:

1. *Distance to a primary school* (DSCHL).

2. *Distance to the nearest bus stop* (DBUS).

3. *Distance to Central Business District* (DCBD). This variable measures proximity of all sample areas in linear distances with respect to the Edmonton CBD. It is a reasonable measure of accessibility as the City of Edmonton is the focal point of economic activities in the sub-region and this measure assigns greater relative importance to communities situated close to the Edmonton CBD. Ingram (1971)[1], however, has advocated a relative accessibility index based on Gaussian curve as being the most applicable of the measures for qualitative measurement of accessibility. Thus another locational variable namely a 'general accessibility index' was calculated for each area.

4. *General Accessibility Index* (GAI): A Gaussian accessibility index was computed as follows:

$$GAI = \sum_{j=1}^{n} 100\, e^{-(d_{ij}^{2}\, v^{-1})}$$

where d_{ij} = distance between i and j ;

v = diameter of the smallest circle circumscibing all communities in this study.

This accessibility index, the sum of a series of relative point accessibility values indicates the degree of spatial proximity for an area vis-a-vis all other areas in the sample. This measure of relative accessibility has the desired properties of smoothness and asymptotically approaches zero as distance increases. This measure also gives greater relative importance to communities within the City of Edmonton because they dominate the sample. It is a superior measure of accessibility because it does not measure accessibility with respect to a fixed point.

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[1] See Ingram (1971),pp.101-107.

2.2.5 Local Public Sector Variables

As the intent here is to capture both interjurisdictional and intrajurisdictional variations in public services, use of expenditure measures of output , while helpful and often used, are not sufficient. McDougall (1976) [9] points out that the use of expenditure measures for local public output is based on the supposition that differences in public expenditures reflect only differences in output. This implies the communities have the same revenue base, the same cost structure, the same technology and are equally efficient in providing local public services. These conditions are in general not met in practice and , therefore , observed differences in expenditure may not reflect differences in public goods. In fact, use of expenditure measures might lead us to erroneously characterise the community with higher costs as having greater provision of local public goods. Even if some of these shortcomings of the expenditure measures of output could be overlooked, it is simply not possible to work out a geographical distribution of city expenditures among city neighbourhoods. An attempt was, therefore , made to construct output measures of public services at the neighbourhood level. In this respect only the five major *'soft'* services namely education, police, fire protection, public transit, and parks and recreation services were included in this analysis. Transportation and environmental health (sewage, water,etc.) were excluded because the sample municipalities now routinely require developers to provide for such infrastructure (namely local streets, water and sewer lines etc.) in new subdivisions. [10] These municipal functions are being performed by developers and are not fully accounted for in municipal spending. Furthermore, other than expenditure measures there are no accepted basis for comparing these services. General government and health and welfare were also not considered as these are not assumed to have any differential impact on intracity neighbourhood residential property values. The following measures of public services were obtained (see Table 2.9 for summary statistics on public services variables).

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[9] See McDougall (1976), p.445.
[10] See Goldberg (1980) and Frieden (1980).

TABLE 2.9 SUMMARY STATISTICS ON COMMUNITY RELATED VARIABLES

Variable	Community	Mean	Standard Deviation	Minimum	Maximum
Achievement Score	City of Edmonton (A)	50.199	5.401	40.400	60.550
	Other Communities (B)	56.847	8.457	45.920	65.130
	Metropolitan Area (C)	51.723	6.716	40.400	65.130
Park Area (acres)	A	268.120	331.140	10.800	1667.200
	B	179.540	123.790	420.000	440.300
	C	247.870	297.370	10.800	1667.200
Recreation Programs Index	A	224.00	0.000	224.000	224.000
	B	84.62	21.273	54.000	106.000
	C	192.14	60.159	54.000	224.000
All Crimes - Per Capita	A	.102	.097	.038	.567
	B	.078	.026	.038	.132
	C	.096	.086	.038	.567
Property Crimes Per Capita	A	.075	.069	.011	.403
	B	.044	.016	.020	.075
	C	.068	.063	.011	.403
Neighbourhood Safety Index	A	.898	.097	.433	.962
	B	.922	.026	.868	.962
	C	.904	.086	.933	.962
Neighbourhood Property Safety Index	A	.924	.070	.597	.989
	B	.956	.016	.925	.980
	C	.931	.063	.597	.989
1977 Residential Fire Rate	A	4.990	2.281	.615	10.909
	B	6.811	3.773	2.878	15.054
	C	5.406	2.741	0.615	15.054
Six year Average Fire Rate	A	4.281	2.935	1.600	16.500
	B	2.162	0.643	1.000	3.200
	C	3.797	2.737	1.000	16.500
1977 Per Capita Residential Fire Loss ($)	A	3.734	3.089	0.256	12.272
	B	3.805	5.042	0.250	15.244
	C	3.751	3.540	0.250	15.344
Six year Average Per Capita Fire Loss ($)	A	9.248	6.324	3.400	35.700
	B	8.425	5.315	2.600	17.000
	C	9.060	6.044	2.600	35.700
Residential Fire Protection Index	A	.995	.002	.989	.999
	B	.993	.004	.985	.997
	C	.994	.001	.995	.999

2.2.5.1 Education

In most previous studies differences in per pupil expenditures have been taken to reflect differences in educational output flows e.g. Oates (1969). Kiesling (1967) [11] studied this hypothesis and concluded

> "the relationship of performance to per pupil expenditure has been found to be disappointingly weak. This would imply among other things, that the utilization of per capita cost figures for an index of public performance is a highly dangerous practice."

Similar findings have also been reported by Werner Hirsch (1973). [12]

In this study education services are measured by grade twelve achievement tests conducted by Alberta Education. These tests cover English, Mathematics, Physics, Biology and Chemistry and are arrived at by evaluating the competence of high school students in content courses. Higher median scores are assumed to represent higher levels of school output. These tests are patterned on the 'Iowa Tests for Educational Development' carried out widely in the U.S.A. McDougall (1974) [13] states that such tests are used by the California State Department of Education to evaluate the effectiveness of public schools. He further reports that the applicability of such a measure of school output is supported by U.S. Department of Health, Education and Welfare (HEW). [14]The HEW study concluded that schools scoring high on other alternative measures of school output such as expectations for excellence, educational plans and desires, per cent of grade twelve graduates going to college , also score high on achievement tests.

It may be noted that differences among schools in average achievement score may be due to differences in (1) average student intelligence (2) the socioeconomic backgrounds of students or (3) the quantity and quality of school inputs. [15] It is argued here that regardless of the relative importance of each in determining academic performance, test scores themselves may accurately measure the perceived benefit flows associated with the local school system. In Tiebout's tradition schools may be viewed as "firms" which use raw materials (students), capital and labour (teachers and school facilities) to produce an output. Under this interpretation differences in firm's output are due to their production efficiency as qualitative differences in the raw

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[11] See Kiesling (1967),pp.356-67.
[12] See Hirsch (1973) ,pp.127-29.
[13] See McDougall (1974),p.47.
[14] See Mayeska,et.al (1969),p.xiv. and Hanushek (1972),pp.20-23.
[15] See Schlack (1977), pp.109-123.

materials are assumed away. Given a number of such firms (schools) within a single metropolitan area (as is the case in our sample), households may "shop around" to transact educational output consistent with their tastes and preferences. [16] Mean achievement scores will thus serve as a useful measure of school output and serve as a reasonable proxy for public service benefit flows to the households. A major limitation of this measure is that to the extent schools attract students from outside the community in which they are situated such a measure may not accurately reflect relative attractiveness of a community for residential location. McDougall (1974), Noto (1976b) and Schlack (1977) have used this measure.

So far we have only stressed the quantity and quality of school inputs and the manner in which they are combined to promote learning experience and have argued that achievement score serves as a useful proxy for school output. School benefits, however, may be tied to the socioeconomic background or the intelligence level of its students and the dynamic process by which group interactions will affect individual attainments even without changes in the school inputs themselves. In each case, however, the achievement score variable seems likely to mirror the perceived benefit flows to the household. [17]

Table 2.10 shows that other sample communities have a higher average achievement score than the City of Edmonton.

2.2.5.2 Parks and Recreation Services

Two types of services are offered by the parks and recreation departments of the sample communities. First, physical facilities for parks and playgrounds are developed. Second, recreation programs are offered for community participation. The following variables attempt to capture both the above aspects of parks and recreation output.

Park Area (PARK): Neighbourhood park areas (in acres) were identified from various maps and also from the Parks and Recreation Department, City of Edmonton Master Plan for

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[16] This argument is based on Schlack (1977), pp.113–115.
[17] See Noto (1976b), McDougall (1974), and Schlack (1977). Given the overwhelming importance of educational expenditures in the budget of local public sector, the attention we have afforded this component of public services package is clearly appropriate. For the Province of Alberta 31% of all local goverment expenditure was for school purposes in 1978. See Chaudry (1980a, 1980b).

1979-83. Park areas for other communities were obtained through a mail survey and interviews of concerned officials. This measure ranks the City of Edmonton higher than other sample communities (see Table 2.9)

Recreation Programs Index (PKIS): Schmandt and Stephens (1960) have advocated the use of municipal output indexes based on the number of subfunctions performed within each service category. This suggestion was found valuable for measuring recreation services output based on subfunctions performed. The data on recreation programs offered by the sample municipalities was obtained through mail surveys and personal interviews of concerned officials. An index based on this data was then constructed treating the sample average as the base. McDougall (1976) uses the same procedure. A major limitation of this measure for this study is that these indexes could not be constructed for various neighbourhoods within the City of Edmonton.

This measure also ranks Edmonton higher than other sample communities (see Table 2.9).

2.2.5.3 Police Protection Services

The incidence of crime relates to the level and effectiveness of police protection and reflect upon the desirability of a neighbourhood as an area in which to live. As the households are unlikely to be equally sensitive to both personal and property crimes, data on total crimes and property crimes in 1977 for each neighbourhood was collected from the City of Edmonton Police Department files and from Statistics Canada for the neighbouring municipalities. Neighbourhood crime incidence was then used to obtain crime rates and safety indexes for each neighbourhood as follows:

1. All crimes - per capita = total crimes/total population
2. Property crimes - per capita = property crimes/total population
3. Neighbourhood safety index = (1 - total crimes/total population)
4. Neighbourhood property safety index = (1 - property crimes/total population)

Variables (1) and (2) above were employed by McDougall (1976) and Hellman and Naroff (1979). [11] Table 2.9 shows that based on the above measures other sample communities have on the average higher levels of safety from crimes than the communities situated in the City of Edmonton.

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[11] See also Greenwood and Wadycki (1973), pp.138-151.

2.2.5.4 Fire Protection Services

The following measures of fire protection output were obtained.

Fire Classification (FC): Alberta municipalities are rated by the Provincial Superintendent of Fire Insurance on a scale of one to ten; one represents the greatest fire protection service, ten represents the lowest level of fire protection service. This rating is based on an evaluation of the municipal water system (pressure, distribution, alternative sources etc.), the response time, staffing and apparatus, training, alarm and communications system and fire department organization. This grading is used by all the insurance companies for fire insurance purposes and is a good measure of municipal fire protection but is inadequate for this study as it does not distinguish subareas in each jurisdiction.

Coulter, MacGillivary and Vickery (1976) and MacGillivary (1978) [19] have emphasized that fire protection effectiveness measures should reflect the two main divisions of fire protection activities, prevention (to minimize the occurance of fires) and suppression (to minimize human and property loss when fire occurs). [20] Keeping this in view, data on two measures of prevention effectiveness (1977 residential fire rate and six year average fire rate) and two measures of suppression effectiveness (1977 per capita residential fire loss in $ and six year average per capita fire loss in $) were calculated as follows.

1977 Residential Fire Count (RFC) and *Residential Property Loss in $* (RFL): The Fire Prevention Branch of Alberta Labour keeps a computerized listing of all incidences of fire. These data were obtained for single and two family residences and then incidences were manually located on a map and each incidence and loss was then related to a neighbourhood in the study area. This procedure identified a fire count and loss due to fire in each neighbourhood in the City of Edmonton and other sample communities. The data on fire count and property loss due to fire are then used to calculate a fire incidence and a fire loss rate for each neighbourhood.

A common criticism levelled against a measure based on fire statistics for any one year is that there may be sufficient year to year variability making yearly estimates

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[19] See Coulter,MacGillivary and Vickery (1976),p.237 and MacGillivary (1978) ,pp.223–235. See also Schofield (1978), pp.65–77.
[20] See Rider (1979).

particularly of fire loss misleading. This, however, is less likely to be a problem for this study as only data on residential fires are examined for a single year.

Both these measures indicate that the City of Edmonton provided a higher level of fire protection to its residents in 1977 than its neighbouring municipalities (see Table 2.10).

Six year Average Fire Rate (SYAFR) and *Six Year Average per Capita Fire Loss in $* (SYAFL): These measures are based on all incidences of fire including commercial and industrial property. Neighbourhood specific measures were based on unpublished data on geographical incidences of fire with the City of Edmonton Fire Department. The same measures for other municipalities were obtained from the Fire Prevention Branch, General Safety Services Division, Alberta Labour.

The two six years measures are less useful for this study than the ones reported earlier as a single catastrophic commercial or industrial fire (a warehouse fire for example) may so distort the losses of a jurisdiction that even six years may not be enough. Moreover, a measure based on all incidences of fire would be only partially useful as jurisdictions with different economic profiles are likely to differ markedly in fire incidence.

Both these measures indicate that the City of Edmonton had a higher incidence of fire than other sample communities (see table 2.9) but this in part may be explained by the fact that the City of Edmonton has a higher percentage of non-residential assessment than other sample communities except for the County of Strathcona and the Town of Fort Saskatchewan (see Table 2.5)

Finally a measure of neighbourhood fire protection level was derived from residential fire incidence data for 1977. This is called 'residential fire protection index (FSR)' and is calculated as follows:

$$FSR = 1-(RFC/HP)$$

where HP = number of single family dwellings

This index, on average ranks Edmonton higher in fire protection than other sample communities (see Table 2.9).

2.2.5.5 Public Transit Services

The public transit accesibility is considered an important determinant of the relative attractiveness of a community. The following variables attempt to measure intercommunity public transit service variations.

Bus Routes (BR): Number of bus routes passing through a neighbourhood.

Per Capita Weekly Bus Trips (PBT): This variable measures the frequency of public transit service to a community.

Both the above measures were calculated from the maps and frequency data published on individual bus routes by the City of Edmonton, Public Transit Department.

2.3 RESIDENTIAL PROPERTY ASSESSMENT AND TAXATION IN METROPOLITAN EDMONTON

In Alberta the Municipal Taxation Act of 1970 grants each municipality the power to levy and collect real property taxes. An appendix to this study provides more details on property taxation and assessment procedures in Alberta. It also provides information on residential assessment practices in Metro Edmonton (see Appendix A). Each year all municipal jurisdictions publish an assessment roll which is used as a basis to determine the mill rate(s) depending upon the revenue requirements for that year. All municipalities in Metro Edmonton have adopted a system of split mill rates which taxes non-residential properties at a higher differential mill rate.

Due to differences in tax-expenditure policies of the various municipal jurisdictions in Metro Edmonton, the residential property tax burden is not uniform as shown by Tables 2.10 and 2.11. St. Albert, Sherwood Park and Fort Saskatchewan had lower and other sample municipalities had higher average residential property taxes per unit than Edmonton in 1977. To determine if the burden of this taxation is uniform within each jurisdiction a summary analysis of data on effective tax rates, i.e. taxes divided by the sales price, and assessment-sales ratio is carried out in the following.

TABLE 2.10 1977 HOUSING PRICES AND RESIDENTIAL PROPERTY TAXES IN METROPOLITAN EDMONTON

Community	Sales Price (P) Mean	Sales Price (P) Standard Deviation	Sales Price (P) Coefficient of Variation	Residential Property Tax Mean	Residential Property Tax Standard Deviation	Residential Property Tax Coefficient of Variation
A) City of Edmonton	64555	19156	.297	482	163	.338
Neighbourhoods						
1	57733	12732		452	152	
2	59425	11128		467	109	
3	65192	3982		544	116	
4	65061	10435		460	76	
5	60478	7827		496	185	
6	60527	10191		398	86	
7	56370	7523		417	81	
8	55234	14084		387	126	
9	47115	7757		345	94	
10	75376	26582		529	190	
11	75225	30115		527	214	
12	84357	37914		577	221	
13	99289	28807		634	260	
14	73423	12282		518	139	
15	89460	21469		675	143	
16	61892	14179		451	146	
17	60245	12373		435	123	
18	57965	13517		450	132	
19	61676	9973		470	94	
20	63288	11680		459	89	
21	64710	9932		490	93	
22	71683	17976		503	106	
23	62932	20841		476	179	
26	80874	30004		595	210	
27	54136	11079		462	87	
28	67015	16631		543	252	
29	69486	12805		576	114	
b) Other Communities	61974	13342	.215	484	114	.235
St. Albert	57349	14790	.258	465	84	.181
Sherwood Park	60142	14338	.238	438	118	.269
Devon	67700	6439	.095	514	59	.115
Fort Saskatchewan	67794	9573	.141	454	62	.136
Leduc	63307	6984	.110	579	107	.185
Morinville	57500	5323	.092	514	112	.218
Spruce Grove	70420	14086	.200	574	137	.239
Stony Plain	64057	7243	.113	570	123	.216
c) Metropolitan Area	64095	18276	.285	482	156	.324

TABLE 2.11 METROPOLITAN EDMONTON - 1977 EFFECTIVE RESIDENTIAL PROPERTY TAX RATES (Mills)

Community	Mean	Standard Deviation	Minimum	Maximum	Coefficient of Variation
a) City of Edmonton	7.558	1.609	1.649	16.588	.213
Neighbourhoods					
1	7.862	1.918	4.902	16.284	
2	7.825	0.852	6.400	9.536	
3	8.394	1.870	3.806	10.551	
4	7.080	0.610	6.306	8.664	
5	8.144	2.540	4.783	16.042	
6	6.584	1.033	5.376	10.269	
7	7.429	1.245	4.556	10.208	
8	6.928	1.040	5.579	8.571	
9	7.300	1.267	5.429	9.453	
10	7.046	1.395	4.673	9.320	
11	7.002	1.680	2.417	10.286	
12	8.112	2.572	5.600	15.556	
13	6.367	1.764	2.467	9.000	
14	7.360	2.001	3.833	15.290	
15	7.659	0.954	5.048	9.229	
16	7.402	2.323	4.087	16.083	
17	7.164	0.952	4.828	9.697	
18	7.747	1.226	5.647	12.281	
19	7.608	0.950	5.149	11.057	
20	7.291	0.707	6.137	8.235	
21	7.602	1.035	5.244	10.756	
22	7.187	1.257	1.649	9.111	
23	8.229	1.505	5.156	11.655	
26	7.527	1.723	4.072	13.085	
27	8.629	1.006	8.827	10.286	
28	7.899	1.915	4.250	16.588	
29	8.362	1.502	6.235	11.368	
b) Other Communities	8.062	3.106	3.704	42.241	.385
St. Albert	8.864	5.326	6.378	42.241	.601
Sherwood Park	7.357	1.457	3.704	10.638	.198
Devon	7.601	0.551	6.707	8.604	.072
Fort Saskatchewan	6.720	0.532	5.366	7.529	.079
Leduc	9.135	1.357	7.105	10.918	.149
Morinville	8.870	1.380	6.823	9.737	.156
Spruce Grove	8.228	1.643	5.923	11.523	.200
Stony Plain	8.924	1.840	7.007	11.469	.206
c) Metropolitan Edmonton	7.648	1.969	1.649	42.241	.257

2.3.1 The Extent of Intrajurisdictional Variations in Effective Tax Rates (T) and Assessment-Sales Ratios (ASRs)

Table 2.11 lists summary statistics on effective tax rates for each neighbourhood. The table shows that there is great deal of intrajurisdictional variation in effective tax rates. The effective tax rate within the City of Edmonton varies from 1.6 mills at the lower end to 16.6 mills at the upper end. The mean and standard deviation [21] are 7.6 and 1.6 mills respectively for Edmonton. Assuming the effective tax rate data is normally distributed, this means that 68.26 percent of all residential properties in Edmonton will have an effective tax rate of between 6.0 to 9.2 mills. The coefficient of variation [22] of T for Edmonton is .213 implying that roughly one-third of all properties were either undertaxed or overtaxed by more than 21.3 percent compared to the sample average. T data on other communities shows less variability with the notable exception of St. Albert. St. Albert data have a mean of 8.9 mills and a standard deviation of 5.3 mills. The coefficient of variation of T for St. Albert is .601 percent indicating that roughly one-third of all properties were either undertaxed or overtaxed by more than 60.1 percent compared to the sample average.

Equivalently, we can also look at assessment-sales ratios (ASR) for the jurisdictions involved (see Table 2.12). Within the City of Edmonton the lowest observed ASR is found in Oliver (1% of market value in Community #12 and the highest in Londonderry (30% of market ratio in Community #28). The mean ASR varies from 11.4% in Boyle Street - McCauley (Community #13) to 15.4% in Castle Downs (Community #27) . The coefficient of variation calculations show that sample communities differ a great deal as to their assessment performance. Assessors as a rule of thumb consider a coefficient of variation of .20 to .15 as satisfactory to good; from .15 to .10 is considered good to excellent; a coefficient of less than .10 is considered outstanding. [23] Using this criteria assessment performance of Metro Edmonton communities can be ranked as follows:

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[21] Standard deviation is a measure of absolute dispersion. It is the root-mean square of the deviations from the arithmetic mean. For a normal or symmetrical distribution about the mean 68.26 % of all values will lie within one standard deviation, 95.46% within two standard deviations and 99.73% within three standard deviations from the arithmetic mean of the data. See Dasso (1973),pp.18-21.

[22] The coefficient of variation (CV) is a relative measure of dispersion and is computed as follows:

CV = Standard Deviation/Mean

See Dasso (1973),p.21.

[23] See Craig (1971), pp.10-26.

TABLE 2.12 METROPOLITAN EDMONTON - 1977 RESIDENTIAL ASSESSMENT-SALES RATIOS

Community	Mean	Standard Deviation	Minimum	Maximum	Coefficient of Variation
a) City of Edmonton	.135	.029	.010	.296	.213
Neighbourhoods					
1	.140	.034	.087	.291	
2	.140	.015	.114	.170	
3	.150	.033	.068	.188	
4	.126	.011	.113	.155	
5	.145	.045	.085	.286	
6	.117	.018	.096	.183	
7	.133	.022	.081	.182	
8	.124	.018	.100	.153	
9	.130	.023	.097	.169	
10	.126	.021	.083	.166	
11	.125	.030	.043	.184	
12	.138	.058	.010	.278	
13	.114	.031	.044	.161	
14	.131	.036	.068	.273	
15	.137	.017	.090	.165	
16	.132	.041	.073	.287	
17	.128	.017	.086	.173	
18	.138	.022	.101	.219	
19	.136	.017	.092	.197	
20	.130	.013	.110	.147	
21	.136	.018	.094	.192	
22	.128	.022	.029	.163	
23	.141	.035	.018	.208	
26	.134	.031	.073	.234	
27	.154	.018	.122	.184	
28	.141	.034	.076	.296	
29	.149	.027	.111	.203	
b) Other Communities	.134	.057	.054	.497	.425
St. Albert	.104	.063	.075	.497	.601
Sherwood Park	.107	.021	.054	.154	.198
Devon	.190	.014	.168	.215	.072
Fort Saskatchewan	.137	.011	.109	.154	.079
Leduc	.179	.027	.139	.214	.149
Morinville	.296	.046	.227	.324	.156
Spruce Grove	.187	.037	.135	.262	.200
Stony Plain	.135	.028	.106	.174	.206
c) Metropolitan Edmonton	.134	.036	.010	.497	.269

Outstanding Performance: Devon and Fort Saskatchewan

Good Performance: Leduc, Morinville, Sherwood Park and Spruce Grove

Poor Performance: Stony Plain and Edmonton

Very Poor Performance: St. Albert

In fact, judging by the coefficient of variation, St. Albert's performance is so poor that roughly one-third of properties are either over or under assessed by more than 60% compared to the sample average . Considering that the mean price of a St. Albert house in 1977 was $57,349, a 60% assessment error (assuming mean assessment-sales ratio of .104) would be a $3579 error and a tax difference of $305.

It may be noted that roughly one-third of the City of Edmonton properties were either over-assessed or underassessed by more than 21% in 1977. This performance does not compare well to that of Metro Toronto where in 1976 only 8.6 % of properties were overassessed by more than 20%, [24] but better than that found by Bird (1960) for several jurisdictions in the U.S. and Oldman and Aaron (1965) for Boston. [25] Oldman and Aaron found the coefficient of variation for ASR using Boston data for 1962 to be equal to .47. Bird analyzed assessment sales ratio data from the 1957 Census of Governments and concluded that within a substantial number of jurisdictions the "situation is one of an almost incredibly wide range of administrative performance". [26] Oldman and Aaron reach similar conclusions for Boston. They state "the study has revealed systematic inconsistencies in property tax assessment..... Explanations for this pattern are obscure". [27]

The extent of intrajurisdictional variations in T and ASR in Edmonton and St. Albert may be a matter of concern as assessing procedures are fairly well established and assessors without exception claim to strive for accuracy and uniformity for single family residences. The following section addresses this question.

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[24] See The Toronto Social Planning Council (1979), p.18
[25] See also Case (1978), p.8
[26] See Bird (1960), p.55.
[27] See Oldman and Aaron (1965), p.48.

2.3.2 Some Thoughts on Causes of Intrajurisdictional Variations in Assessment-Sales Ratios

A detailed scientific examination of assessment variations is beyond the scope of this study. However, it is of interest to speculate on possible sources of assessment errors. We draw heavily upon Bancroft (1971) and Case (1978) [28] for this summary.

There are two principal sources of errors in assessment; (1) inadvertant misestimation of fair market value of a house; and (2) randomness in selling price. A great deal of improvement is possible in reducing the first source of error. Misestimation could arise due to a number of factors. The foremost being the utilization of incorrect housing market models in assessment technologies. Even the best known housing market models fail to incorporate imperfect markets, transaction costs and market segmentation and price discrimination. In the presence of these imperfections there are more likely to be equilibrium price distributions rather than equilibrium market prices. This being the case it is difficult to say without the knowledge of shape of these distributions, what statistical measure of central tendency be chosen to represent fair market value of a composite bundle of attributes.

Fortunately, existence of the Multiple Listing Service (MLS) overcomes to an unknown extent the above imperfections. Therefore, for the Edmonton region, to the extent that this problem exists, it should be less serious than other areas where the MLS service is not available. The problem that could be serious for such an area is an inadequate account for public service characteristics of the neighbourhood. A look at the assessment records at the City of Edmonton revealed that such indeed was the case. Neighbourhood attributes are rarely and always inadequately represented in assessments. The assessors fail to properly differentiate between malleable structural characteristics and public sector attributes that are difficult to add or remove from the house. Improper evaluation of such attributes leads to serious assessment error. As Case (1978) [29] points out

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[28] See Case (1978),p.17–32.
[29] See Case (1978), pp.60–61.

> "the value of attributes that are less malleable often diverge from replacement costs as locational quasi-rents arise. In addition formal exposition of the traditional approach provide little guidance for the valuation of location specific or neighbourhood characteristics."

Thus proper valuation of public sector and community related characteristics and utilization of a multiple regression approach will go a long way in reducing within jurisdiction assessment variations. In Metro Edmonton residential land was assessed in 1977 at 65% of market value in the year preceding the last general assessment (1973 for Edmonton) but improvements were assessed at 45% of 1963 construction or replacement costs in the City of Edmonton, less depreciation. [30] 1963 construction technology may be outmoded for 1977 and may have contributed to assessment difficulties. Introduction of the 1979 assessment manual and uniform assessment of land and improvements (65% of market value) may have overcome these difficulties in more recent years.

Other sources of assessment errors include changes in market value through time and infrequent updating, errors resulting from simple inefficiency in the application of the generally accepted assessing technology, the rate of change in the community. Perhaps the last factor may account for major assessment variations in St. Albert. Even in the presence of perfect assessment procedures some amount of variation of ASR within each jurisdiction will still remain. Our discussion, however, indicates that significant improvement in assessment performance is possible through more frequent updating and revaluation of assessment with the utilization of a multiple regression models [31] taking proper account of neighbourhood and public services characteristics.

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[30] See Finnis (1979), pp.122-125.
[31] See International Association of Assessing Officers (1974).

3. EFFECTIVE TAX RATE AND PUBLIC SERVICES CAPITALIZATION

3.1 INTRODUCTION

The main goal of this study is to provide an improved empirical framework for studying public sector capitalization into housing prices in Edmonton, to determine the degree of capitalization, and to draw implications of these findings for public policy analysis. Oates' (1969, 1973) pioneering work in this area serves as a good starting point for our study in section 3.2 of this chapter. An application of a generalized functional form to the hedonic price function is then discussed. The chapter also presents a possible solution to the multicollinearity problem encountered in this study. Capitalization results based on alternate econometric techniques are then compared. The analysis is extended to derive estimates of both intrajurisdictional and interjurisdictional property tax capitalization. The final section presents calculations as to the degree of tax and expenditure capitalization and summarizes capitalization conclusions based on Oates' approach and basic extensions of it.

3.2 STANDARD OATES APPROACH

Following Oates' methodology, in this study the selling price of a house is depicted as a function of the valuations of the various characteristics of the house, namely: structure, site, neighbourhood, public services, and taxes. This framework lends itself conveniently to multiple regression analysis.

The first step in this empirical application is to select a set of regressors from among the variables described in Chapter 2 . Several regression runs were initially done to choose significant regressors and to screen out variables which did not contribute to the explanatory power of the model. In this initial search, the regression analysis produced relatively stable and robust results on those variables measuring the house specific characteristics. By contrast, public sector characteristics other than the effective tax rate variable (T) , displayed extreme sensitivity to minor modifications in the specification of the estimating equation. For example, inclusion of MUNC and SCHL in a given equation produced statistically insignificant coefficients for both variables, whereas

when introduced alone, both variables had statistically significant coefficients. This result obtains because of the high degree of collinearity among the two variables. The partial correlation coefficient for the two variables was 0.92647. LOCAL, on the other hand, showed some robustness and was retained to capture the combined effects of various components of local public expenditure. All the output indicators of public services also lacked robustness. The results on these variables were extremely sensitive to the specification of the equation. Again this instability was traced to the presence of a high degree of multicollinearity. These variables were, however, retained for later applications when we present a possible solution to the multicollinearity problem encountered in this study.

Only the structure , site and neighbourhood variables which showed consistency in their signs and significance were included in the final regression equations reported here. Among the structure characteristics ROOMS, DSIZE , LRA, AGE, FP, DFR, BATH, GAR, and BRST were retained as these were found to be major determinants of house price. BRA (bedroom area), KA (kitchen area), and DRA (dining room area) were excluded because they failed to register statistically significant coefficients. DUP (duplex dummy), TWO (two storey dummy), and FA (forced air heating dummy) were excluded because they either were statistically insignificant in certain runs or they displayed signs contrary to our *a priori* expectation. DUP and TWO in certain specifications of the model had significant positive coefficients whereas FA had a significant negative coefficient. A negative FA coefficient was consistent with Hamilton's study but Hamilton could not explain this result. [1] In our sample FA presents extraneous information as most homes in the area have forced-air heating. BROMS (bedrooms) was excluded because it was highly collinear with ROOMS.

Among the site and neighbourhood characteristics, LSIZE (lot size) , GAI (General Accessibilty Index) and Y (median family income) contributed significantly to the explanatory power of the equation and were retained. The site characteristics, DSCHL (distance to school) and DBUS (distance to a bus stop) were excluded due to statistical insignificance. PPD (number of persons per single family dwelling (POP/HP)) served as a neighbourhood density measure but was excluded as it was collinear with DCBD, GAI and

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[1]See Hamilton (1979), p.177

Y. Furthermore, contrary to our expectations, it had a positive significant coefficient but did not contribute significantly to the explanatory power of the equation. Its inclusion contributed only .01 to R^2. DCBD was excluded because it was collinear with both GAI and Y.

We noted in Chapter 2 that the City of St. Albert was the only community included in our sample which is almost completely residential . St.Albert had only 5.8 % non-residential actual assessment compared to 33% for the sample average for 1977. Moreover, St. Albert showed greater variations in the assessment ratio compared to other sample communities. In view of the pre-eminence of residential property taxes in local finance in St. Albert we expect a greater degree of tax capitalization than for other sample communities. These considerations prompted us to try both intercept and effective tax rate slope dummies for St. Albert in regression analysis. An intercept dummy did not appear significant and was subsequently dropped from the analysis but an effective tax rate slope dummy (T24) was retained as it always appeared with the correct sign and was in general statistically significant.

Empirical results following Oates' approach are presented in Table 3.1. Equation 3.11 includes T (effective tax rate) and LOCAL (per capita local expenditure) as regressors in a house price equation. It yielded expected signs for all the variables. ROOMS was positive and significant and indicated a premium of $715 with the addition of an extra room. An additional bathroom was valued at $1697 and an additional garage stall at $2900. One extra square foot of dwelling size and lot size contributed $18 and $3 to house price respectively. An expansion of living room area would contribute $42 per square foot to house value. All the structure dummies were also positive and significant. BRST (brick/stone exterior) added $7442 to the value of the house whereas a fireplace (FP) contributed additional $2387 and DFR (family/recreation room) was valued at $3213. The house price was also found to be positively related to GAI. Median income (Y) had a positive but statistically insignificant coefficient.[2] The age of the house served as a proxy

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[2] A great deal of controversy has arisen in economics literature over the inclusion of income as an explanatory variable in hedonic price regressions. Several researchers have argued that income should not be included since property value is a market determined relation and thus determined by the demand of all potential purchasers not just the demand of current occupants. This argument may have some validity when aggregate data is used in a property value determination model. In our case, inclusion of median income can be justified in that it serves as a proxy for neighbourhood quality . See Oates (1973) and Pollakowski (1973).

TABLE 3.1
PUBLIC SECTOR CAPITALIZATION ESTIMATION I (OATES I)
(875 Observations)
Dependent Variable = P

EQUATION	3.11	3.12	3.13	3.14	3.15
METHOD	OLS	TSLS	Box-Cox λ =-.15	OLS	Box-Cox λ =-.13
INTERCEPT	6543.5	5534.0	3.4000000	17937.0	4.024200
	(0.9)	(0.7)	(15.9)	(5.2)	(42.8)
ROOMS	715.4	715.81	.0130330	311.2	.009806
	(2.1)	(2.0)	(2.2)	(1.0)	(1.4)
DSIZE	17.7	17.596	.1812400	16.1	.181730
	(15.4)	(15.2)	15.7	(14.5)	(14.8)
LRA	42.0	42.403	.0823800	36.9	.084908
	(6.4)	(6.3)	(8.1)	(5.8)	(7.7)
AGE	-179.1	-177.60	-.0005186	-206.6	.000711
	(-7.2)	(-7.0)	(-8.4)	(-8.6)	(-9.5)
FP	2386.8	2451.3	.0032840	2038.0	.003636
	(2.3)	(2.3)	(1.3)	(2.0)	(1.2)
DFR	3213.3	3255.6	.0087360	2528.8	.009509
	(4.4)	(4.4)	(5.1)	(3.6)	(4.5)
BATH	1697.3	1663.1	.0044120	1675.9	.005318
	(2.3)	(2.2)	(1.5)	(2.4)	(1.4)
GAR	2897.8	2898.6	.007750	2883.4	.009750
	(4.8)	(4.7)	(5.3)	(4.9)	(5.5)
BRST	7441.8	7413.5	.0170270	6811.5	.019767
	(4.2)	(4.2)	(4.0)	(4.0)	(3.8)
LSIZE	3.1	3.01	.1424800	2.8	.145550
	(10.0)	(9.5)	(9.5)	(9.4)	(9.5)
GAI	28.7	27.8	.0000370	19.7	.001163
	(1.5)	(1.4)	(0.2)	(1.3)	(0.5)
Y	115.4	128.0	.0064660	184.5	.009135
	(0.9)	1.0	(1.2)	(1.6)	(1.4)
T	-2132.6	-1941.6	-.0610400	-1795.9	-.066885
	(-9.5)	(-4.3)	(-9.9)	-8.3	(-9.3)
T24	-158.1	-236.9	-.0039200	-547.6	-.005831
	(-.8)	(-.9)	(-8.9)	(-2.7)	(-10.6)
LOCAL	13.9	13.6	.0563240		
	(1.7)	(1.7)	(1.2)		
PSI				7191.7	.026039
				8.9	(7.2)
R^2	.6275	.6272	.686900	.6575	.704900
S.E.E	11251	11256	.02689	10788	.03268

for the physical condition of the house and was negatively related to the house price.

Both the effective tax rate (T) and per capita local expenditures variables were significant at .001 and .05 levels respectively using a two tailed t-test of significance and had the expected signs. Equation 3.11 shows that one mill increase in effective tax rate (or $64.09 increase in tax per household) leads to $2133 decrease in house selling price. The effective tax rate slope dummy for St. Albert was statistically significant only at the .25 level. Nevertheless, it indicates a slight differential impact of property taxes on house prices in St. Albert. A one mill increase in effective tax rate in St. Albert would depress the average house price by $2291. LOCAL (per capita local public expenditure) was positively related to house price. A one dollar increase in per capita local expenditure would result in appreciation of the average house price by $14.

Oates (1969, 1973) employed an aggregate data set for his model estimation and recognized simultaneity among property taxes, public services and residential property values. For this reason, he also treated fiscal variables as endogenous and re-estimated his model using the Two Stage Least Squares (TSLS) approach. Comparing his OLS and TSLS estimates he concluded that his data set did not reveal any simultaneity bias. Hedonic price studies using dis-aggregated data in general do not find any significant simultaneity bias in their estimation. [3] It is, therefore, of interest to see if any improvement would be obtained by incorporating a correction for possible simultaneity bias that might be present in our data set.

A TSLS approach was employed treating T and LOCAL as endogenous variables. Municipal grants (MG), per capita equalized assessment (PCEA), percent non-residential assessment (NRA%) percent young (YOUNG) ,percent old (OLD), roads per square kilometer of area (RPK), population growth rate (PGR) and persons per single family dwelling (PPD) were used as instrumental variables. We observe from Table 3.1 equation 3.12 that TSLS approach offered no improvement over OLS estimation. The coefficient and t-ratios in equations 3.11 and 3.12 are quite close for all except property tax variables. The coefficient of T was smaller and of T24 larger in TSLS as compared to OLS. Nevertheless, the observed difference between the coefficents of T in both estimations was not statistically significant as the 95% confidence interval for T obtained

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[3] See Noto (1976a) and Anderson (1981)

from OLS encompasses the TSLS estimate. The OLS estimate of T is preferable due to a smaller standard error. The OLS equation has also a slight edge over TSLS in terms of the overall fit of the regression as evidenced by a higher R^2 and a lower standard error of the estimate. The results, therefore, suggest that the simultaneity bias is insignificant in this study.

Oates (1969, 1973) also paid some attention to variables transformation. He found that public sector variables performed better in log as compared to linear formulation. *No* such improvement was realized in this study. Oates, however, did not rigorously investigate the appropriate functional form for his model . The following section estimates the hedonic price function using a generalized functional form.

3.3 PROPERTY TAX CAPITALIZATION ESTIMATES BASED ON A HEDONIC FUNCTION EMBODYING GENERALIZED FUNCTIONAL FORM

In empirical economics, our theory often does not provide any guidance as to the choice of appropriate functional form. This is, however, a fairly important question as Kendall and Stuart (1968, p. 85) have stated:

> "Although natural considerations of convenience or technique may dictate that the observations be made on a variable *y*; it still has to be decided which function of *y* is to be used for the purpose of analysis. There is no reason why the quantity measures, rather than some function of it, should be best suited to the assumptions of the model."

In hedonic price studies researchers have often in the past employed linear, log-linear or semi-log specifications on an *ad hoc* basis. Only recently some attention has been focussed to determine optimal functional form in hedonic literature. It has been discovered that most of the specific functional forms are special cases of the general transformation of the variables problem discussed by Box-Cox. [4]The Box-Cox technique has also been found useful for inducing normality on observations from skewed distributions. Thus Judge, Griffiths, Hill and Lee (1980) have advocated its use to overcome the heteroskedacity problem (non-normal disturbances) often encountered in

[4] See Zarembka (1974), p.83. For an excellent summary of Box-Cox transformations, see Spitzer (1982) . Noteworthy empirical applications include Zarembka (1968, 1974), White(1972, 1978) , Spitzer(1976, 1978), Kau and Lee (1976) and Chang (1977).

cross-sectional analysis.[5] Gujarati (1978) notes that variable transformation could also be helpful if presence of multicollinearity is detected.[6]

Box and Cox (1964, pp. 211-263) were the first to consider transformation of the variable, in a power family context By applying their formulation the hedonic index could be recast into the following form:[7]

$$P(\lambda) = (P^{\lambda} - 1)/\lambda = \alpha_o + \beta\{(X_i^{\lambda} - 1)/\lambda\} + \varepsilon_i \tag{3.31}$$

Let us evaluate 3.31 for some selected values of λ. First, for $\lambda = 0$, the expressions $(P^{\lambda} - 1)/\lambda$ and $(X_i^{\lambda} - 1)/\lambda$ appear to be indeterminate. However, any finite positive number, say P can be approximated as

$$P = e^{\log P} = 1 + \log P + \frac{1}{2!}(\log P)^2 + \frac{1}{3!}(\log P)^3 + \ldots$$

Thus, for a non-zero P, the L.H.S. of equation 3.31 can be written as follows:

$$\begin{aligned}(P^{\lambda}-1)/\lambda &= (1/\lambda)\ (e^{\lambda \log P} - 1)\\ &= (1/\lambda)\ \{1 + \lambda \log P + \frac{1}{2!}(\lambda \log P^2) + \ldots -1\}\\ &= \log P + (\lambda/2!)\ (\log P)^2 + (\lambda^2/3!)\ (\log P)^3 + \ldots\end{aligned}$$

For $\lambda = 0$

$$\lim_{\lambda \to 0} (P^{\lambda} - 1)/\lambda = \log P$$

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[5] See Judge, Griffiths, Hill and Lee (1980) pp.308-311
[6] See Gujarati (1978) p.186
[7] Our discussion here is based on Kmenta (1971), pp.467-468.

and similiarly

$$(X_i^{\lambda} - 1)/\lambda = \log X_i$$

This means that for $\lambda = 0$ and for positive values of X_i and P the regression equation reduces to:

$$\log P = \alpha + \beta \log X_i + \varepsilon_i$$

the log-linear form.

For $\lambda = 1$ we obtain:

$$P - 1 = \alpha + \beta (X_i - 1) + \varepsilon_i$$
$$P = \overset{*}{\alpha} + \beta X_i + \varepsilon_i$$

the linear specification

where $\overset{*}{\alpha} = \alpha - \beta + 1$

If, however, only a power transformation of the dependent variables is used then the function would be reduced to a semi-log form for $\lambda = 0$ It may be noted that the transformation is continuous around $\lambda = 0$ and is also invariant to the units in which P is measured provided a constant term is used in the equation. [1]

It is important to realize the implications of this transformation for interpretation of marginal effects. The partial effect of X_i on P can be traced as follows: Consider equation 3.31 and let us call

$$P^* = (P^{\lambda} - 1)/\lambda \text{ and } X^* = (X^{\lambda} - 1)/\lambda$$

then

$$\partial P/\partial X_i = \partial P/\partial P^* \cdot \partial \overset{*}{P}/\partial X^* \cdot \partial X^*/\partial X$$

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[1] See Zarembka (1974) p.85

where $\partial P/\partial P^* = P^{1-\lambda}$

$\partial P^*/\partial X^* = \beta_i$

$\partial X^*/\partial X = X^{\lambda - 1}$

$$\therefore \partial P/\partial X_i = P^{1-\lambda}\ \beta_i\ X_i^{\lambda-1} = \beta_i\ (P/X_i)^{1-\lambda}$$

and the price elasticity of X_i

$$\xi_{px} = \partial P/\partial X_i \cdot X_i/P = \beta_i (X_i/P)^{\lambda}$$

For $\lambda = 0$

$$dP/dX_i = \beta_i\ (\bar{P}/\bar{X}_i)$$

or $\beta_i = dP/dX_i \cdot (\bar{X}_i/\bar{P})$

and for $\lambda = 1$

$$dP/dX_i = \beta_i$$

3.3.1 Box-Cox Regressions

The following equation incorporating Box–Cox transformations was estimated:

$$(P^{\lambda} - 1)/\lambda = \alpha_0 + \beta_i\ \{X_i^{\lambda} - 1)/\lambda\} + \varepsilon_i$$

where P = sales price of a house (as already defined)

X = the set of regressors used in equation 3.11

Optimal value of λ was obtained by a maximum likelihood procedure. The log-likelihood function attained a global maximum for λ =-.15. Equation 3.13 in Table 3.1 is estimated using this transformation. Values of the log-likelihood function and R^2 for various values of λ are listed in Table 3.2 and are also graphed in Figure 1. An approximate 95% confidence region for λ is determined by the condition:

$$\ln L_{MAX}(\hat{\lambda}) - \ln L_{MAX}(\lambda) < 1/2\ \psi^2_{.05} - 1.92$$

yielding

$$-.25 < \lambda < -.05$$

This interval does not contain the value of $\lambda = 0$ or $\lambda = 1$. Thus *ad hoc* specification of both log-linear and linear formulation would have been inappropriate.

Equation 3.13 indicates that the Box-Cox transformation offered some improvement over the results obtained with untransformed data. The effective tax rate slope dummy for St. Albert was now highly significant. The precision of estimates for ROOMS, DSIZE, LRA, AGE, DFR, GAR, Y, T and T24 was increased but this transformation resulted in lower precision for coefficients of the remaining variables.

The untransformed fiscal variables show that taxes were related negatively and per capita local expenditure positively with the house selling price. The Box-Cox regression equation 3.13 shows that one mill increase in residential property taxes would depress the average house price by $1983 and a one dollar increase in local expenditure per capita would increase the average house price by $7. (See Table 3.1)

3.4 COMPARISON WITH THE OATES RESULTS

Table 3.3 summarizes estimates obtained relating marginal effects of fiscal variables on house selling prices as well as house price elasticity estimates with respect to these variables obtained from the application of various econometric techniques. To facilitate comparison with Oates' work, similar computations were also carried out using coefficient estimates presented in his 1969 and 1973 papers. For our sample of communities the average house price is $64,095 and a one mill increase in residential property taxes would decrease house prices by a $1942 to $2133 range. A similar tax

Table 3.2
BOX-COX TRANSFORMATION METRO EDMONTON DATA

λ	LOG LIKELIHOOD FUNCTION	R^2
0.000	-9180.385138	0.6881
1.000	-9395.686104	0.6275
-0.618	-9224.291251	0.6626
0.382	-9227.315994	0.6788
-0.236	-9177.493072	0.6848
-0.382	-9187.264990	0.6790
-0.146	-9176.001828	0.6869
-0.090	-9176.714011	0.6877
-0.180	-9176.178469	0.6862
-0.125	-9176.129925	0.6873
-0.159	-9176.012886	0.6867
-0.138	-9176.029551	0.6871
-0.151	-9175.997871	0.6868
-0.154	-9176.000476	0.6868
-0.149	-9175.998191	0.6869
-0.152	-9175.998410	0.6868
-0.150	-9175.997841	0.6869

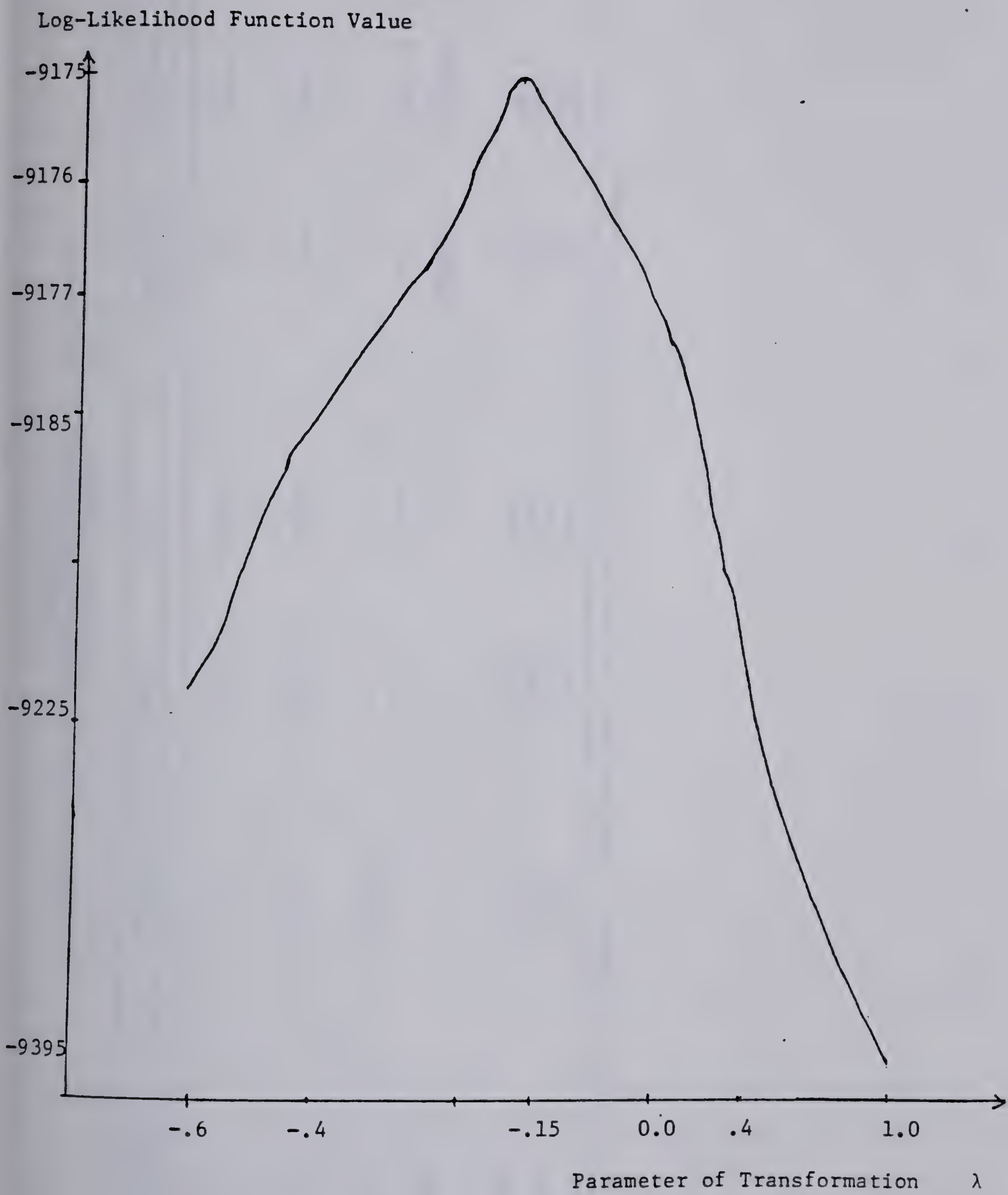

Figure 3.1 THE LOG-LIKELIHOOD FUNCTION (METRO EDMONTON DATA)

Table 3.3
MARGINAL EFFECTS OF PUBLIC SECTOR VARIABLES ON HOUSE PRICES:
TRADITIONAL APPROACH*

EQUATION	METHOD	dP/dT	ξ_T	dP/dLOCAL	ξ_{LOCAL}
3.11	OLS	-2132.6	-.25448	13.9	.20264
3.12	TSLS	-1941.6	-.23168	13.6	.19823
3.13	BOX-COX (λ =-.15)	-1983.2	-.23665	7.3	.10615
OATES				dP/dSCHL	ξ_{SCHL}
1969	OLS	-150.0	-.1875	9.1	.1666
	TSLS	-150.0	-.1875	14.0	.2552
1973	OLS	-175.0	-.2187	10.3	.1875
	TSLS	-208.3	-.2604	13.7	.2500

* In this and all subsequent tables and text d is used as a symbol for a partial derivative.

increase for his sample (average house price $20,000) would depress residential property values on the average by $150 to $208. Since the rate of taxation is lower and residential property values higher for our sample, the elasticity estimates obtained by the two studies are fairly close. House price elasticity for effective tax rate range from −.23 to −.25 for our sample as compared to the −.19 to −.26 range obtained by Oates.

It is also interesting to note the range of estimates obtained by the two studies relating the impact of local expenditures. Our results show that a one dollar increase in local expenditure per capita would increase the average house price by $7 to $14. House price elasticity with respect to these expenditures is estimated in the range of .11 to .21. Oates found that a one dollar increase in educational expenditure per pupil would appreciate median property value by $9 to $14. The property value elasticity with respect to these expenditures is calculated to show a range of .17 to .26. Thus both studies conclude in favour of significant impact of public sector on residential property values although the impact of taxes is greater and of expenditure relatively smaller in this study.

3.5 THE MULTICOLLINEARITY PROBLEM AND POSSIBLE SOLUTIONS

Most property tax capitalization studies have observed some degree of collinearity in their data but have ignored this problem. [9] Like them, we detected this problem early on in our analysis but, unlike them, we will attempt to deal with this problem. An early detection of this problem occurred due to a number of anomolies encountered in multiple regression analysis.

1. A great deal of instability was shown by regression coefficients of public sector variables. Coefficients of several output indicators of the public sector as well as expenditure measures of public services either appeared statistically insignificant or displayed a wrong sign.
2. In general the estimated coefficients were extremely sensitive to the addition or deletion of apparently insignificant variables. Estimated coefficients of variables were sensitive to the combination of variables in a given run.

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[9] See Noto (1976a) and Brueckner (1982) for example. They observed this phenomenon but did not deal with it.

These difficulties led us to explore the possible sources of these problems. We found that multicollinearity was indeed a serious problem in our data set. Table 3.4 lists simple correlation coefficients for a selected number of regressors . Partial correlation coefficients reported in Table 3.4 in general violate the Farrar and Glauber (1967) rule. [10] This rule states that simple correlation coefficients must not exceed the coefficient of multiple determination. If this rule is violated then multicollinearity is deemed harmful and something must be done about it. [11]

In sections 3.2 and 3.3 of this chapter, we selected variables so as to avoid the multicollinearity problem. This worked well but in the process we could not make use of some very valuable data which could be employed to enhance the explanatory power of our model. Thus a logical next step in our analysis would be to search for a method that would yield stable coefficient estimates and which could also be used in conjunction with the Box-Cox procedure to determine the optimal functional form. We have earlier observed that the optimal functional form is data dependent and should not be decided in an *ad hoc* manner. Most researchers have erred in the past by deciding to use a double-log or a semi-log form at the outset of investigation.

The presence of high collinearity among independent variables casts a great shadow of doubt on regression results. As Johnston (1972, p. 160) notes , the precision of estimates falls making it difficult to determine the relative influences of independent variables. Specific estimates may have large errors which may be highly correlated. Also the sampling variances of the coefficients may be large. The result of these procedures is that variables may be incorrectly dropped from the analysis due to insignificance when in reality the true relationship has gone largely undetected. There may not be enough independent movement of the explanatory variables to enable us to determine the individual effects.

An important econometric technique called ridge regression [12] has recently been applied to obtain stable implicit characteristic prices for data sets plagued by multicollinearity. The same technique could be investigated for application here. This

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[10] See Judge et al.(1980),p.459
[11] See Judge et al.(1980), Gujarati (1978) for a comprehensive treatment of this problem.
[12] See Vinod (1978) for a survey of ridge regression and related techniques. Strawderman (1978) has improved upon Hoerl and Kennard (1970) 's work and has presented a minimax generalized ridge estimator . This procedure , however, is not yet incorporated in well known computer package programs.

Table 3.4
SELECTED SIMPLE CORRELATION COEFFICIENTS

VARIABLES	CORRELATION COEFFICIENT
ROOMS & BROMS	.80692
DSCHL & DBUS	.54863
RFL & RFC	.66182
SYAFR & SYAFL	.93560
AC & SYAFL	.67820
AC & SYAFR	.74072
PC & AC	.94636
PC & SYAFR	.67820
PC & SYAFL	.74074
DCBD & Y	.44400
GAI & PARK	-.86391
YOUNG & OLD	-.88059
TRANSIT & MUNC	.98449
MUNC & SCHL	.92647
MUNC & SKL	.76291

relatively new estimation technique is, however, a biased estimation technique. Since the matrix X X is almost singular where multicollinearity is serious, Hoerl and Kennard (1970) suggest that we multiply each diagonal element of this matrix by (1+k) starting by a very small value of k and increasing it until we obtain stable regression coefficient estimates. Thus the ridge technique provides a lower mean square error at the expense of some bias. One should assess whether the gain in mean square error is worth the loss introduced by the bias. If the objective of a research study is merely prediction then there may be a net gain with ridge estimation but our objective is to obtain stable and unbiased coefficients. Here ridge regression does not offer much promise. Maddala also observes that:

> "...it (ridge regression method) is a purely statistical solution to the multicollinearity problem and hence might not appeal to many economists" (1977, p.192).

In spite of the many conceptual difficulties ridge estimation presents in our case, it is of some interest to see if the ridge procedure combined with a Box-Cox transformation of our data set would yield stable hedonic prices with correct signs. We first used Box-Cox procedure to obtain optimal transformations of the dependent variable only. The optimal in this case was -.27. The house sale price was then transformed by this value and then a series of ridge regressions were run progressively raising values of k by increments of 0.1 starting with k = 0.0 (OLS regression). The ridge estimation did not offer any improvement over the OLS results. As the value of k was increased, the statistical fit of the function as evidenced by R^2 got progressively worse. Furthermore, neither the coefficient estimates converged to any stable values nor did they necessarily appear with correct signs. Thus we must search for an alternate approach to deal with this problem and to derive improved capitalization estimates. The next section describes such an approach.

3.6 CANONICAL ANALYSIS

Alternately, to overcome the multicollinearity problem we could use prior information to form composite variables. Principal component analysis and canonical analysis are the competing techniques used to create composite variables. [13]

The canonical analysis is preferable to the principal component analysis for the purposes of this study. The latter technique selects components on the basis of intercorrelation of variables that are available and attempts to maximize the explained variance in these variables alone. Thus though the first principal component may pick up the major portion of the variance of independent variables but it may not necessarily be the one that is most correlated with the dependent variable. In fact there is no necessary relationship between the order of principal components and the degree of their correlation with the dependent variable. Furthermore, a linear combination of all variables representing the weighted sum of a diverse classification of characteristics may not be open to any meaningful economic interpretation.

Canonical analysis on the other hand forms linear combinations of original variables in such a way that the resulting composite indexes are maximally correlated with the dependent variable. The following paragraphs provide a brief non-technical introduction to this technique.

3.6.1 Canonical Analysis - Brief Introduction

In canonical analysis, coefficients are chosen to form a linear combination of a set of standardized independent variables (Z) in such a way that of the infinite number of possible linear combinations for the standardized independent variables (Z) the resultant linear combination of Z is maximally correlated with the dependent variable (or a linear combination of dependent variables). Let x and y be defined by:

$x = \Sigma a_i Z_i$ where $Z_i = (X_i - \bar{X}_i)/\sigma_{x_i}$

$y = y$

Canonical correlation analysis selects those values for the a 's such that the correlation coefficient between x and y is the maximum possible value. Thus x represents that combination of Z set variables which has the highest correlation with the y vector. Thus

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[13]See Levine (1977), Morrison (1967), Cooley and Lohnes (1971) for a detailed description of these techniques.

the pair x and y are most highly related to one another. The correlation coefficient between x and y is termed as canonical correlation, r, and the x and y pairs are called canonical variates. The maximum number of such variates that can be extracted depend upon the maximum number of variables in the smaller set. If the smaller set is only a vector then there will be only one solution for each subset of independent variables.

This technique was introduced in econometrics by Hotelling (1936) and brief summaries of the general model are given in Tintner (1952), Theil (1971), Johnston (1972) and Judge et al.(1980). A detailed account of the procedure appears in Anderson (1958) and Kendall and Stuart (1966).

In our analysis, at the first stage we utilize canonical analysis to form composite variates. In subsequent regression analysis these variates replace the original variables. This procedure was adopted because the original variables subset was collinear. [14]

3.6.2 Canonical Composite Indices

The canonical analysis was used to reduce the number of original independent variables to a subset of a manageable size. Three composite indexes comprising structure, site and public services characteristics were obtained. Table 3.5 presents the summary statistics relating each of these indices. The composition of site and public services indices show that we were able to utilize some valuable data which could not be used in regressions ignoring multicollinearity correction. PSI index is composed entirely of output indicators of public services. The index is positively related to AS (achievement score), PARK (park area), PKIS (park and recreation subprogram index), PBT (per capita bus trips per week by each neighbourhood) and negatively to RFR (residential fire rate) and PTC (per capita total crimes by each neighbourhood). Summary statistics also indicate that 13.2% of the variance in the price of housing is explained by the public services

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[14] What if one of the independent variables not in the subset is correlated with original variables in the subset replaced by the composite variate ? This poses no difficulty so long as the independent variable in question is not strongly correlated with the new composite variate. In fact, in such a situation the regression equation using canonical estimators would have a smaller mean square error than the one with OLS estimators in their original form. If on the other hand, the independent variable in question is more strongly correlated with the composite variate than the original variable set in pairwise relation , then the technique is not helpful for it would lead to imprecise estimates. This problem is not encountered in our analysis. Much work remains to be done on the efficiency and unbiasedness of canonical estimators but McCallum (1970) has shown that under certain conditions the composite estimators will have smaller mean square error than OLS estimators.

Table 3.5
SUMMARY STATISTICS ON CANONICAL COMPOSITE INDEXES

STRUC. CHARACTERISTICS INDEX (STRUCI)		SITE CHARACTERISTICS INDEX (SITEI)		PUBLIC SERVICES INDEX (PSI)	
VAR.	COEFF.	VAR.	COEFF.	VAR.	COEFF.
ROOMS	.05677	LSIZE	.92467	Achievement Score(AS)	.33285
DSIZE	.53633	GAI	.18999	Park Area (PARK)	.09333
LRA	.27661	DCBD	-.08230	Rec. Prog. Index(PKIS)	.03310
AGE	-.22166	DSCHL	-.07592	Resid. Fire Rate(RFR)	-.26402
FP	.09090	DBUS	-.08540	Per Capita Weekly Bus Trips(PBT)	.79720
DFR	.20751	PPD	-.25411	Per Capita Total Crime(PTC)	-.19164
BATH	.06926				
GAR	.17802				
BRST	.12541				
Percent of Variance Explained	53.3		23.2		13.2
Canonical Correlations	0.72988		0.48180		0.36318
Chi-Square	66.813		229.801		123.063
Significance Level	.0001		.0001		.0001

index. Similarly 53.3% and 23.2% of the variance in the price of housing is explained by structure and site composite indexes.

The canonical correlation presented is simply the product–moment (Pearsonian) correlation coefficient between the composite indexes and the price variable. As expected, the correlation between the structural component index and price is very high, whereas such a relationship of the price with composite indexes of public services and site characteristics is considerably weaker. The chi–square test indicates highly significant association between price and each of the composite indices. The exact information on the composition of individual indices is revealed by the standardized coefficients of the original variables which are reported in Table 3.5. The size of the coefficients are indicative of the relative contribution of the original variables comprising each canonical index.

3.6.3 Multiple Regression Analysis Using Canonical Composite Indices

Two types of applications of these indices were attempted. First PSI was used to replace LOCAL but retaining all other variables in their original form. Equation 3.14:Table 3.1 illustrates this application. This formulation offered considerable improvement over equation 3.11. All the variables appeared with the correct signs and were statistically significant. T24 was now statistically significant at .005 level and PSI at .001 level. The coefficient estimates of AGE, Y, and T24 showed improvement over equation 3.11. R^2 was now higher and standard error of the estimate lower than obtained by 3.11. The coefficient of PSI suggests that a one percentage point increase in PSI would contribute $7192 to average house price. The impact of one mill increase in residential property taxes on house price is estimated at –$1796 in all sample communities except St. Albert. For St. Albert similar figure would be –$2343.5.

The application of a Box–Cox transformation to the model specified in equation 3.14 led to further improvement in the overall explanatory power of the regression and to more precise estimates for tax variables. (See equation 3.15) Optimal was –.13 and coefficients of T and PSI in untransformed form would be –1813.9 and 7036.3 respectively. (See Table 3.7)

Finally the three composite indices replaced structure, site and public services characteristics in Table 3.6:equation 3.61. This specification produced good results. R^2 showed improvement over equation 3.11 while the number of variables were reduced to a manageable size and all the variables appear with correct *a priori* signs. The inclusion of composite indices of vectors of house characteristics eliminated much of the volatility in the size, significance and sign of coefficients experienced by this study. In addition, these indices helped to focus on major characteristics of each group. Thus the multicollinearity problem was avoided without dropping any variables. Empirical results as reported in Table 3.6:equation 3.61 again confirm that housing prices are affected negatively by residential property taxes and positively by public services in the Metropolitan Edmonton region.

A Box-Cox regression ($\lambda = 0$) using the same model as in equation 3.61 produced only minor improvements. The results are reported in Table 3.6:equation 3.62. It resulted in greater precision for T, T24 and STRUCI and lower precision for coefficient estimates of Y and PSI. Equation 3.62 implies a coefficient of −1874.5 for T and 5523.7 for PSI in their untransformed form.

Table 3.7 summarizes coefficient and elasticity estimates for regressions using any or all composite indices. A range of (−1743) to (−1874) is suggested for the coefficient of T and a range of 5523.7 − 7191.7 for the coefficient of PSI. The house price elasticity estimates with respect to effective tax rate fall in the range of (−0.21) to (−1.22) and with PSI in the interval of 0.09 to 0.11.

Once again, the operation of the demand side of Tiebout's model is confirmed. What conclusions can be drawn from this econometric exploration as to the degree of public sector capitalization is the focus of the next section.

3.7 THE EXTENT OF PUBLIC SECTOR CAPITALIZATION

The estimated magnitude of capitalization of property taxes and public services depends upon the assumptions regarding the discount rate (r) and the life of the asset (i). The discount rate represents a homeowner's opportunity cost. A measure of this opportunity cost would be the difference between the interest rate on mortgages and

Table 3.6
PUBLIC SECTOR CAPITALIZATION USING COMPOSITE INDICES

(875 Observations)

EQUATION	3.61	3.62
METHOD	OLS	BOX-COX (λ=0)
INTERCEPT	39528.0	11.086
	(17.3)	(160.44)
STRUCI	22382.0	0.31248
	(27.6)	(28.3)
SITEI	8231.6	0.11310
	(10.1)	(10.0)
Y	112.9	0.005234
	(1.0)	(0.4)
PSI	6258.2	0.08618
	(8.1)	(5.8)
$\dot{T}$	-1743.2	-.22368
	(-8.2)	(-9.06)
T24	-498.2	-.020427
	(-2.7)	(-8.7)
R^2	0.6558	0.6625
S.E.E.	10758.0	0.14688

Table 3.7

THE COEFFICIENTS AND ELASTICITIES OF PUBLIC SECTOR VARIABLES

WITH RESPECT TO HOUSE PRICE

EQUATION	3.14	3.15	3.61	3.62
METHOD	OLS	BOX-COX (λ =-.13)	OLS	BOX-COX (λ =0)
dP/dT	-1795.9	-1813.9	-1743.2	-1874.5
ξ_{T}=dP/dT.T/P	-.21431	-.21645	-.20801	-.22368
dP/dPSI	7191.7	7036.3	6258.2	5523.7
$\xi_{PSI} = (dP/dPSI)(PSI/P)$	.01122	.10978	.09764	.08618

the rate of appreciation of the house. [15] Table 3.8 presents statistics for the period 1971 – 1981 on mortgage lending rates and house price appreciation in metro Edmonton. The table shows that an Edmonton homeowner's opportunity cost for the period of 1971 – 1976 was generally negative due to a very high rate of appreciation of house prices during the same period. Thus the use of a very low discount rate would be appropriate to derive capitalization results. If ,however, the 1974–76 period is omitted the average net cost of capital over 1972–1981 for an Edmonton resident was 1.8%. 1977 data also suggests a discount rate of 2% . Thus it would be reasonable to assume a discount rate of 2% for capitalization calculations. [16] This view of the appropriate discount rate is, however, open to serious objections as it implicitly assumes that homeowners are myopic in their investment decisions. The choice relating appropriate discount rate remains a subject of much controversy and debate in Canada and elsewhere. [17] In view of this debate alternate calculations using a discount rate of 5 percent are also presented.

Three alternate assumptions are used for the life of housing stock when using a discount rate of 2 percent. Assumption A assumes $i=40$. . This is the most commonly used assumtion in capitalization studies. The second assumption (B) depreciates the structural portion over 40 years whereas lot value stays the same. Assumption C uses an infinite time horizon. Capitalization calculations using a discount rate of 5 percent were also done assuming an infinite time horizon (Assumption D).

The following capitalization implications emerge from the regression results reported in earlier sections.

3.7.1 The Magnitude of Property Tax Capitalization

Once a decision is reached as to reasonable values of r and i, standard procedures are available to compute degree of capitalization. [18] For a house having a life of forty years, we would have:

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[15] See Reinhard (1981).
[16] A study prepared for the Economic Council of Canada by Tarasofsky, Roseman and Waslander (1982) estimates the after tax real rate of return on capital employed in nonfarm, nonfinancial sector in Canada in 1976 to be 4.5 per cent.
[17] Jenkins (1973, 1977) using Canadian data for 1965–74 estimates that incremental domestic savings (postponed consumption) become available at a social time preference rate of 4.14 percent. See Burgess (1981), p.383.
[18] See Oates (1969) for an application of this procedure.

Table 3.8
EDMONTON HOMEOWNER'S OPPORTUNITY COST

DATE	NHA MORTGAGE RATE	MLS HOUSE PRICE APPREC. FROM PREVIOUS YEAR	HOMEOWNER'S OPPORTUNITY COST OF CAPITAL
	(1)	(2)	(3)=(1)-(2)
June 1971	8.8		
June 1972	9.0	6.5	2.5
June 1973	9.2	14.6	-5.4
June 1974	10.7	28.2	-17.5
June 1975	10.9	26.4	-15.5
June 1976	11.9	32.0	-20.1
June 1977	10.2	8.3	2.1
June 1978	10.2	14.0	-3.8
June 1979	10.9	7.2	3.7
June 1980	13.1	10.1	3.0
June 1981	18.5*	8.0	10.5
AVERAGE	11.2	15.5**	-4.3

* 5-year conventional mortgage rate
** compound average
Source: (1) The Bank of Canada Review(Various Issues)
(2) Edmonton Real Estate Board. Unpublished Data

$$P = \sum_{i=1}^{40} \{A_n/(1+r)^i\} = \sum_{i=1}^{40} (A - tP)/(1+r)^i \tag{3.71}$$

where P = house price ;

A = gross annual rental income ;

A_n = net (after tax) rental income ;

r = discount rate

Solving for P , we get :

$$P = \left[A \{\sum_{i=1}^{40} 1/(1+r)^i\}\right] / \left[1 + t \{\sum_{i=1}^{40} 1/(1+r)^i\}\right] = (A.m) / (1 + t.m) \tag{3.72}$$

For i = 40 and r = .02, the capitalization multiplier m as obtained from standard mathematical tables is 27.355. [19]

Now for t_0=.008 and P=$64,095

Equation 3.72 yields A=$2,855.9

A one mill increase in residential property tax (t_1=.009) would result in the following changed price , P^1

$$P^1 = \left(Am/(1+t_1 m)\right) = \$62,692. \tag{3.73}$$

The change in house price consistent with 100% capitalization of the increased tax bill would be:

$$\Delta P = P^1 - P = \$62,692 - \$64,095 = -\$1403. \tag{3.74}$$

Under assumption A (r=.02,i=40), it is this theoretical value against which we will compare our estimates obtained in earlier sections. Table 3.9 presents capitalization estimates based on regressions presented in Sections 3.2 through 3.6 using assumptions A, B , C and D. Capitalization results based on Oates' studies have also been calculated under assumptions A,C and D and are presented here for comparison. Under assumption C our estimates range from 88% to 96% capitaliztion based on traditional approaches and 79%

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[19] See Cissell and Cissell (1977) or Selby (1972).

Table 3.9
PUBLIC SECTOR CAPITALIZATION SUMMARY

Assumptions:
A. ($r=.02$, $i=40$)
B. ($r=.02$, $i(\text{structure})=40$; $i(\text{land})=\infty$)
C. ($r=.02$, $i=\infty$)
D. ($r=.05$, $i=\infty$)

EQUATION	METHOD	RESIDENTIAL PROPERTY TAXES (%) A	B	C	D	LOCAL PUBLIC EXPENDITURES (%) A	B	C	D
(i) TRADITIONAL APPROACH									
3.11	OLS	152	124	96	228	15	11	8	20
3.12	TSLS	138	113	88	208	15	11	8	20
3.13	BOX-COX (λ =-.15)	141	116	90	212	8	6	4	11
(ii) USING COMPOSITE INDICES									
3.14	OLS	128	105	81	192	9	7	5	13
3.15	BOX-COX (λ =-.13)	129	106	82	194	9	7	5	12
3.61	OLS	124	102	79	186	8	6	4	11
3.62	BOX-COX (λ =0)	134	109	85	200	7	5	4	10
(iii) OATES' RESULTS									
1969	OLS	49		37	59	33*		18*	45*
	TSLS	49		37	59	51*		28*	70*
1973	OLS	57		44	69	38*		21*	51*
	TSLS	68		52	82	50*		27*	68*

* School expenditures only

to 85% based on the composite index approach. Oates' results on the other hand would show a range of property tax capitalization from 37% to 52%. Larger capitalization estimates are obtained when using assumptions A, B and D.

3.7.2 The Measurement of Expenditure Capitalization

A simple procedure is used to measure the extent of public expenditure capitalization. Assuming r=.02 and i=40, a dollar payable periodically is worth $27.355 today (from tables). We will compare the effect of a dollar increase in per household expenditure (the coefficient of LOCAL divided by the average number of persons per family) on house price obtained from regression results against this theoretical value. As an illustration equation 3.11 indicates that there would be an increase of $4.09 (=$13.9/3.4) in house price for an additional dollar public expenditure per household. This suggests a capitalization of 14.95% (=$4.09/27.355) of local public expenditures.

Table 3.9 suggests a range of 8 to 15 per cent expenditure capitalization based on the traditional approach. To determine the degree of capitalization based on the public services index, a translation of the coefficients of PSI in terms of equivalent coefficients for LOCAL is first attempted as follows:

$$(dP/dLOCAL)^{*} = (dP/dPSI)*(dPSI/dLOCAL). \qquad (3.75)$$

Values for the first expression on the right hand side of 3.75 are easily obtained from regression results reported earlier in this chapter. $(dPSI/dLOCAL)^{*}$ is approximated from the following equation;

$$PSI=0.25436+0.0011854\ PSE. \qquad (3.76)$$

$$(0.4319) \qquad (1.216)$$

$$(R^2=.1743\ S.E.E.=.22238\ N=9\ )$$

where PSE=local expenditures for services included in PSI.

Based on equation 3.75 a coefficient of $7197.7 for PSI in equation 3.14 would be approximately equivalent to a coefficient of $8.525 if per capita dollar values were used to measure the output of local public services.

Expenditure capitalization estimates based on $(dP/dLOCAL)^*$ are reported in Table 3.9. The traditional approach suggests a range of 4 to 20 percent whereas regressions using composite index of local public services imply expenditure capitalization of 4 to 13 percent under alternate assumptions regarding r and i.

We carried out similar computations on the regression results reported by Oates (1969 and 1973). His results suggest a range of 21% to 70% capitalization of school expenditures. Sufficient details to carry out the same computations for his municipal expenditure variable were not available.

A very high degree of property tax capitalization coupled with very low level of expenditure capitalization appears to suggest that local governments in metro Edmonton may have a tendency to overprovide local public goods. This question will be further investigated in chapter 4. We now attempt to improve estimates of property tax capitalization by investigating both inter- and intra-jurisdictional aspects of this phenomenon in the next section.

3.8 INTERJURISDICTIONAL AND INTRAJURISDICTIONAL PROPERTY TAX CAPITALIZATION ESTIMATION

The capitalization literature in Oates' tradition failed to distinguish empirically between intrajurisdictional tax capitalization due to random assessment errors within each jurisdiction and interjurisdictionnal capitalization due to differences in the effective tax rate among jurisdictions. These studies by and large utilize aggregate data which is unsuited to such a task. Fortunately the data set used for this study is readily amenable to such an analysis. To capture the separate effects of these two influences the basic model in section 3.2 is respecified as follows: [20]

$$P = \alpha_0 + \beta_i X_i + \gamma_1 TMT + \gamma_2 MT + \delta_1 TMT24 + \delta_2 MT24 + \varepsilon_i \qquad (3.81)$$

where MT = Municipal Effective Tax Rate

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[20] This formulation was suggested by Goodman (1982)

and TMT = T − MT =Difference between house effective tax rate and municipal effective tax rate.

TMT24 = TMT slope dummy for St.Albert

MT24 = MT slope dummy for St.Albert

X_i = Structure, site and public services /expenditure variables

The MT variable in the above equation captures interjurisdictional influences and TMT will measure the effect of intrajurisdictional property tax differentials for the sample communities. Three variants of equation 3.81 are estimated using both OLS and Box−Cox regressions and the estimating equations are reported in Tables 3.10 and 3.12.

In equation 3.101 TMT variable is significant at the .001 level using a two−tailed t−test and MT is significant at .15 level. This equation suggests that a one mill increase in TMT and MT would depress average house price by $2197 and $347, respectively. LOCAL is significant at .05 level and has a coefficient of 14.9. This is consistent with equation 3.11.

A Box−Cox transformation based on λ =−.68 improves the explanatory power of the model and the transformed tax variables are now statistically significant. In particular, this transformation leads to remarkable improvement in the precision and statistical significance of TMT24 and MT24. LOCAL on the other hand is no longer statistically significant. The Box−Cox regression 3.102 suggests smaller impact of TMT, MT and LOCAL on house prices. The coefficients and elasticities in untransformed form are reported in Table 3.11.

Equation 3.103 differs from equation 3.101 in that LOCAL is replaced by PSI. This change resulted in improvement in the overall fit of the regression as well as the statistical significance of the tax variables coefficients. The coefficient estimate of TMT is now smaller and that of MT much larger than obtained in equation 3.101. The coefficients of tax variables in equation 3.103, however, inspire greater confidence as PSI and MT are not collinear ($r_{PSI,MT}$ =.05) whereas LOCAL and MT show some degree of collinearity ($r_{LOCAL,MT}$ =−.45439)

A Box−Cox transformation of the model based on λ =−.62 resulted in further improvement in R^2. TMT 24 became highly significant. The computed coefficients for untransformed tax variables are reported in Table 3.13. The Box−Cox transformation lead

Table 3.10
ESTIMATION OF WITHIN AND ACROSS JURISDICTIONS PUBLIC SECTOR CAPITALIZATION
(875 Observations)
Dependent Variable P

EQUATION	3.101	3.102	3.103	3.104
METHOD	OLS	BOX-COX	OLS	BOX-COX
		(λ =-.68)		(λ =-.62)
INTERCEPT	-8216.7	1.3868	17180.0	1.5052
	(-0.6)	(147.93)	(1.6)	(225.57)
ROOMS	693.9	.000079	309.5	0.000113
	(2.0)	(2.1)	(1.0)	(1.7)
DSIZE	17.6	.022574	16.1	0.027436
	(15.3)	(17.6)	(14.5)	(16.7)
LRA	41.3	.004079	36.8	0.005523
	(6.2)	(8.7)	(5.8)	(8.4)
AGE	-177.8	-0.000001	-206.2	-.000003
	(-7.1)	(-9.1)	(-8.6)	(-9.7)
FP	2368.7	.000016	1986.1	0.000029
	(2.2)	(2.4)	(2.0)	(2.3)
DFR	3266.9	.000023	2539.0	0.000042
	(4.5)	(5.1)	(3.6)	(4.8)
BATH	1652.5	.000013	1669.1	0.000025
	(2.2)	(1.4)	(2.4)	(1.4)
GAR	2838.0	.000023	2868.9	0.000044
	(4.6)	(5.9)	(4.9)	(6.0)
BRST	7541.9	.000043	6818.4	.000081
	(4.2)	(3.9)	(4.0)	(3.7)
LSIZE	3.1	.028447	2.8	0.033805
	(9.9)	(8.5)	(9.3)	(8.6)
GAI	41.4	.000052	19.3	0.000037
	(1.9)	(1.3)	(1.0)	(0.9)
Y	152.8	.000025	188.9	0.000035
	(1.2)	(0.4)	(1.6)	(0.4)
TMT	-2197.2	-.000011	-1850.0	-.000021
	(-8.6)	(-7.1)	(-7.4)	(-6.7)
MT	-346.8	-.000042	-1691.6	-.000684
	(-1.2)	(-1.2)	(-2.3)	(-2.2)
TMT24	-74.2	-.000042	-3958	-.000077
	(-0.1)	(-15.8)	(-.99)	(-15.2)
MT24	-461.9	-.000008	-610.4	-.000014
	(-1.4)	(-2.9)	(-2.0)	(-3.0)
LOCAL	14.9	.001653		
	(1.8)	(0.3)		
PSI			7196.5	0.000076
			(8.8)	(4.7)
R^2	.6283	.7475	.6576	.7498
S.E.E.	11253	.00007	10800	0.00014

Table 3.11
THE COEFFICIENTS AND ELASTICITIES OF PUBLIC SECTOR VARIABLES WITH RESPECT TO HOUSE PRICE I*

EQUATION	3.101	3.102
METHOD	OLS	BOX-COX (λ =-.68)
dP/dTMT	-2197.2	-1386.5
ξ_{TMT}	-.016032	-.010124
dP/dMT	-346.8	-263.5
ξ_{MT}	-.03885	-.029523
dP/dLOCAL	14.9	2.0
ξ_{LOCAL}	.21746	.02925

*Please see Table 3.13 for equations 3.103 and 3.104

Table 3.12
INTRAJURISDICTIONAL AND INTERJURISDICTIONAL PUBLIC SECTOR CAPITALIZATION USING COMPOSITE INDICES

EQUATION	3.121	3.122
METHOD	OLS	BOX-COX (λ =-.42)
INTERCEPT	37522.0	2.4
	(4.6)	(565.5)
STRUCI	22342.0	.002997
	(27.3)	(28.98)
SITEI	8267.7	.001048
	(10.1)	(10.0)
Y	122.48	.000306
	(1.1)	(.6)
PSI	6263.4	.000582
	(8.1)	(4.0)
TMT	-1778.3	-.000228
	(-7.3)	(-7.4)
MT	-1471.4	-.0025510
	(-2.4)	(-1.9)
TMT24	-411.09	-.000534
	(-1.0)	(-10.7)
MT24	-576.9	-.000136
	(-1.9)	(-3.3)
R^2	0.6559	0.6877
S.E.E.	10770	.0013667

to a reduced coefficient for TMT and a small increase in the coefficient for MT. PSI coefficient was also substantially smaller with this transformation. (See equation 3.104).

Finally, the new set of tax variables were combined in a run with structure, site, public services composite indices and Y. The results appear as equation 3.121 in Table 3.12. The estimated coefficients of tax variables as well as their standard errors are now somewhat smaller than those reported in equation 3.103. Thus the confidence interval for estimated coefficients would be more precise. The standard error of the estimate is now smaller.

A Box–Cox transformation for λ =–.42 of the model specified in equation 3.81 showed a small improvement in the overall explanatory power of the equation as evidenced by the log–likelihood function. However, it produced remarkable improvement in the statistical significance of TMT24 and MT24. (See equation 3.122) The coefficient estimates for untransformed TMT, MT and PSI variables are reported in Table 3.13 (equations 3.121 and 3.122). The three coefficients assume smaller values with the Box–Cox transformation than in their linear formulation. The elasticity estimates for TMT and MT are also displayed in Table 3.13.

Thus we conclude that the regression results suggest that both the random assessment errors within each jurisdiction as well as differences in the effective tax rates are completely capitalized in house prices. Also the use of the output index of public services leads to improved estimates of property tax capitalization.

3.9 THE DEGREE OF TAX AND EXPENDITURE CAPITALIZATION - SOME CONCLUSIONS

The capitalization calculations were carried out following the procedures outlined in Section 3.7 and the results are summarized in Table 3.14. OLS estimates are in general higher than those obtained with Box–Cox regressions. Under assumption B, intrajurisdictional property tax capitalization estimates range from 65 to 132% based on inclusion of LOCAL, 61 to 87% based on replacement of LOCAL by PSI, and 72 to 84% based on inclusion of composite indices.

Interjurisdictional property tax capitalization estimates show a much wider range. The degree of such capitalization is small using the traditional approach but those

Table 3.13
THE COEFFICIENTS AND ELASTICITIES OF PUBLIC SECTOR VARIABLES
WITH RESPECT TO HOUSE PRICE - II

EQUATION	3.103	3.104	3.121	3.122
METHOD	OLS	BOX-COX (λ =-.62)	OLS	BOX-COX (λ =-.42)
dP/dTMT	-1850.0	-1296.4	-1778.3	-1527.3
ξ_{TMT}	-.013498	-.009466	-.012975	-.011152
dP/dMT	-1691.6	-1719.7	-1471.4	-1039.1
ξ_{MT}	-.18951	-.19266	-.16485	-.11641
dP/dPSI	7196.5	4633.0	6263.4	3897.0
(dP/dLOCAL)*	8.531	5.492	7.425	4.619

Table 3.14
INTRAJURISDICTIONAL AND INTERJURISDICTIONAL PUBLIC SECTOR CAPITALIZATION SUMMARY

Assumptions:
A. ($r=.02$, $i=40$)
B. ($r=.02$, i(structure)$=40$; i(land)$= \infty$)
C. ($r=.02$, $i= \infty$)
D. ($r=.05$ $i= \infty$)

EQUATION	3.101	3.102	3.103	3.104	3.121	3.122
Method	OLS	BOX-COX (λ =-.68)	OLS	BOX-COX (λ =-.62)	OLS	BOX-COX (λ =-.42)
RESIDENTIAL PROPERTY TAX CAPITALIZATION						
A. Intrajur.(%)						
IA	132	83	111	78	107	92
IB	103	65	87	61	84	72
IC	75	47	63	44	61	52
ID	182	115	153	107	147	126
B. Interjur.(%)						
IA	24	18	118	120	102	72
IB	20	15	99	100	86	61
IC	15	11	76	78	66	47
ID	37	28	181	184	157	111
LOCAL PUBLIC EXPENDITURE CAPITALIZATION (%)						
IA	16	2	9	6	8	5
IB	12	2	7	4	6	4
IC	9	1	5	3	4	3
ID	22	3	13	8	11	7

estimates may be in error due to collinearity between MT and LOCAL. This range of capitalization is considerably narrowed if we use one or all of composite indices. These results demonstrate the superiority of PSI over expenditure measures in a capitalization study. The suggested range by these estimates is 61% to 100% under assumption B. In four out of six cases reported in Table 3.14, the intrajurisdictional tax capitalization influences appear stronger than interjurisdictional effects. The relative strength of these influences is, however, an empirical question only since there is no strong theoretical basis for expecting one influence to be stronger than the other. One reason for a greater degree of intrajurisdictional tax capitalization in our sample communities may be a greater perception of assessment/sales ratio differentials within each community than municipal effective tax rate differentials across communities. Moreover, our analysis in Chapter 2. confirms that these perceptions are consistent with reality as the assessment/sales ratios show a more pronounced variation than displayed by municipal effective tax rate.

Public expenditure capitalization based on expenditure measures of public services indicates 1% to 22% capitalization whereas when output indicators of public services are used, this range is narrowed to 3% to 13% under four alternate assumptions regarding i and r.

3.10 CONCLUDING REMARKS

This chapter utilized large scale disaggregated data on real estate transactions for the Edmonton metropolitan area and carried out a test of the capitalization hypothesis following Oates' approach. It may be recalled that this approach advocates the use of the effective tax rate variable in estimating tax capitalization.

An improvement in the statistical fit of the function was obtained with the application of a generalized functional form suggested by Box and Cox (1974). The presence of multicollinearity in our data set was recognized and in dealing with this problem, canonical analysis performed better than variable selection, ridge regression and the principal component analysis. Canonical composite indices of public services, structure and site characteristics were formed to overcome the severe collinearity in the data. The public services indices so composed proved useful in determining the extent of public sector capitalization. The standard Oates approach was also modified to estimate

public sector capitalization within and across jurisdictions.

The results suggest that the assessment errors within each jurisdiction as well as differences in effective tax rates across jurisdictions are completely capitalized in house prices. The degree of public expenditure capitalization is observed to be very small and is estimated to be less than 25% under alternate assumptions regarding the discount rate (r) and the time horizon (i).

4. CAPITALIZATION OF PROPERTY TAX PAYMENTS AND PUBLIC SERVICES AND TESTS OF ALLOCATIVE EFFICIENCY IN THE LOCAL PUBLIC SECTOR

Chapter 3 presented tax capitalization estimates based on the effective tax rate variable. This chapter presents property tax capitalization estimates using the annual property tax bill ($) per household. This approach was initially suggested by King (1977) and later improved upon by Reinhard (1981). They , however, only investigated the capitalization of interjurisdictional variations in property taxes using aggregate data. We utilize their approach in estimating both within and across jurisdictions capitalization of property taxes using disaggregated data.

In section 4.1 we apply the King–Reinhard approach to our data and compare the capitalization estimates of our sample with those of King and Reinhard. Section 4.2 summarizes public sector capitalization results based on alternate assumptions regarding the discount rate and the time horizon. In section 4.3 we modify King–Reinhard model to investigate both inter and intrajurisdictional aspects of tax capitalization and the results are summarized in section 4.4. An overview of capitalization results obtained in chapters 3 and 4 is presented in section 4.5 . Capitalization analysis is extended to investigate the efficiency of local public goods provision in metropolitan Edmonton in section 4.6 using Brueckner's model and a balanced budget analysis. Finally, section 4.7 sums up the capitalization findings of this study and discusses their implications in the light of the Tiebout literature.

4.1 PUBLIC SECTOR CAPITALIZATION ESTIMATION USING THE KING-REINHARD APPROACH

To empirically estimate equations 1.44 and 1.45 of Chapter 1 while retaining the same set of variables as used in Chapter 3 requires 1.44 to be modified as follows:

$$P + (b_1/r)\ \mathrm{TAX} + (b_2/r)\ \mathrm{TAX24} = \alpha_0 + \Sigma \beta_i X_i \qquad (4.11)$$

where TAX24 = (TAX)(D24)

D24 = Dummy for St. Albert

The above equation can also be written as:

$$P(1+(b_1/r)t+(b_2/r)(t)(D24))= \alpha_0 + \Sigma\beta_i X_i \quad (4.12)$$

or

$$P = (\alpha_0 + \Sigma\beta_i X_i)/(1+(b_1/r)t+(b_2/r)(t)(D24)) \quad (4.13)$$

Equation 4.11 was estimated using OLS and by constraining the coefficient of TAX and TAX24 to optimal values by a search process using the maximum likelihood procedure. The iterative procedure attempted to maximize the log-likelihood function by varying b_1/r and b_2/r. Global maximum was attained when $b_1/r = 51.0$ and $b_2/r = 8.0$. These restrictions were incorporated in the final estimating equation and the results appear as equation 4.11 in Table 4.1.

Slightly different results are obtained if we follow a search procedure proposed by Hildreth and Lu (1960) [1] and adopted by Reinhard. The Hildreth and Lu procedure in our case would work as follows: First we select values of (b_1/r) and (b_2/r) and calculate say Δ_1, such that

$$\Delta_1 = 1+ (b_1/r)_1 t + (b_2/r)_1(t)(D24)$$

All the independent variables are then divided by Δ_1. These transformed variables are then regressed on price and the residual sum of squares (RSS) is calculated in each case. This procedure is repeated until the RSS is minimized. The value of Δ, which minimizes RSS, Δ^*, is then used to transform the dependent variable. In our case RSS was minimized using $b_1/r = 49.5$ and $b_2/r = 10.0$. Using equation 4.12, P was then multiplied by (1+49.5t+10.t.D24). Equation 4.12 was then estimated using the TSLS approach where LOCAL was treated as an endogenous variable. Instrumental variables included MG, PCEA, NRA%, YOUNG, OLD, RPK, PGR and PPD. The resulting equation is reported as 4.12 in Table 4.1. The results offered no significant improvement over restricted least squares (RLS) results of equation 4.11.

It may be noted that the model appearing in equations 4.12 and 4.13 is non-linear both in variables and parameters. Thus a linear estimation of this non-linear model may

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[1]See Gujarati (1978) p.247.

Table 4.1
PUBLIC SECTOR CAPITALIZATION ESTIMATION USING THE KING-REINHARD APPROACH I
(875 Observations)

EQUATION	4.11	4.12	4.13	4.14
Method	RLS	TSLS	Non-Linear	RLS
INTERCEPT	-11365.	-11126.	-11382.	6962.5
	(-1.1)	(-1.1)	(-393.5)	(1.6)
ROOMS	1074.3	1062.2	848.4	5571.1
	(2.2)	(2.2)	(2.2)	(1.2)
DSIZE	23.3	23.1	27.4	21.1
	(14.6)	(14.6)	(14.7)	(13.8)
LRA	59.0	58.6	60.4	51.5
	(6.4)	(6.5)	(6.8)	(5.9)
AGE	-257.2	-253.9	-247.9	-290.7
	(-7.5)	(-7.4)	(-6.9)	-8.8
FP	2504.4	2507.5	2559.9	1910.0
	(1.7)	(1.7)	(152.9)	(1.4)
DFR	4377.6	4369.7	4600.1	3421.1
	(4.4)	(4.4)	(25.1)	(3.6)
BATH	2169.3	2144.5	2278.8	2171.1
	(2.1)	(2.1)	(9.9)	(2.2)
GAR	3910.3	3871.0	4025.5	3823.5
	(4.6)	(4.6)	(12.2)	(4.7)
BRST	10689	10552	10648.0	9793.9
	(4.4)	(4.3)	(410.5)	(4.2)
LSIZE	4.2	4.2	4.5	3.9
	(10.1)	(10.0)	(9.8)	(9.6)
GAI	42.7	39.0	25.7	34.2
	(1.7)	(1.6)	(1.1)	(1.8)
Y	114.8	126.1	160.8	180.9
	(0.7)	(0.8)	(1.0)	(1.1)
TAX	-51.0	-49.5	-60.7	-48.5
			(-8.4)	
TAX24	-8.0	-10.0	-16.0	-15.0
			(-2.5)	
LOCAL	18.8	18.7	18.6	
	(1.7)	(1.7)	(4.3)	
PSI				9093.6
				(8.3)
R^2	.6066	.6062		.6334
S.E.E.	15659	15536		14908
LF*			-9376.1	

*LF stands for Log-Likelihood Function

not lead to correct estimation of the parameters. We, therefore, estimated equation 4.13 by non-linear regression based on a Quasi-Newton algorithm [2] and the results are reported in equation 4.13, Table 4.1. The coefficients of TAX and TAX24 are estimated to be −60.7 and −16.0 respectively by this method. This procedure enabled us to obtain more precise estimates of all the regressors without encountering the heteroskedasticity problem experienced by Reinhard with the use of an iterative linear method. [3] It may also be noted that the estimated coefficient for structure and site characteristics are in general slightly higher with the non-linear method. The exceptions are the coefficients for ROOMS, AGE, BRST and GAI. LOCAL had about the same coefficient no matter what procedure was used except that its statistical significance increased with the use of a non-linear method.

Equation 4.14 repeats the procedure used in equation 4.11 but LOCAL is now replaced by PSI. The optimal values obtained for TAX and TAX24 were −48.5 and −15.0 respectively. PSI had a positive significant coefficient. R^2 is slightly higher and the standard error of the estimate smaller with the use of this model.

Table 4.2 presents results for models incorporating composite indexes and using the restricted least squares and non-linear methods. Equation 4.21 provides a somewhat better fit to the data than equations 4.11 and 4.14. STRUCI, SITEI and PSI are statistically significant at .025 level and Y is significant at .25 level. TAX and TAX24 display coefficients of −47.5 and −14.0 respectively. Non-linear estimation based on these indexes also shows superior results than the application of the same method using individual characteristics. The value of the log-likelihood function and the statistical significance and precision of estimates for TAX and TAX24 is now higher than in 4.13. Equation 4.22 suggests that optimal values for the coefficients of TAX and TAX24 would be −51.4 and −18.2 respectively. Both the coefficients are statistically significant at .025 level. PSI is also significant at .001 level.

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[2] See Brodlie (1977) and Judge et al.(1980) for a discussion of this method.
[3] See Reinhard (1981) p.1258

Table 4.2
PUBLIC SECTOR CAPITALIZATION ESTIMATION USING KING-REINHARD APPROACH II
(875 Observations)

EQUATION	4.21	4.22
Method	RLS	N L
INTERCEPT	37509.0	36866.0
	(17.6)	(73.9)
STRUCI	29645.0	31398.
	(26.2)	(23.1)
SITEI	11493.0	11670.
	(10.4)	(85.2)
Y	94.4	126.1
	(0.6)	(1.1)
PSI	7750.1	8094.1
	(7.5)	(30.3)
TAX	-47.5**	-51.4
		(-12.1)
TAX24	-14.0**	-18.2
		(-3.6)
R^2	.6305	
S.E.E.	14804	
LF		-9342.5

** Coefficients constrained to optimal values obtained by a search procedure

4.2 PUBLIC SECTOR CAPITALIZATION SUMMARY

Table 4.3 presents capitalization estimates under four alternate assumptions regarding the discount rate (r) and the time horizon (i):

Assumption A : r=.02, i=40;

Assumption B : (i) r=.02, i=40 for structure and (ii) r=.02, i= ∞ for land;

Assumption C : r=.02, i= ∞

Assumption D : r=.05, i= ∞

Under assumption A the degree of tax capitalization varies from 186 to 222% using variables in their original form and from 174 to 188% with the use of one or more composite indices. King (1977) and Reinhard (1981) estimates indicate tax capitalization of 63% and 91% respectively.

It may be noted that the extent of capitalization depends directly on both the discount rate and the time horizon assumed. For example, if we assume a discount rate of 2% and an infinite time horizon (assumption C), our estimates would range from 95 to 102% based on all equations reported in Section 4.1 except equation 4.13 which would indicate capitalization of 121%. An intermediate range of capitalization is indicated by calculations based on assumption B (see Table 4.3) and much higher estimates are obtained using assumption D.

The regression results reported in Section 4.1 also indicate local expenditure capitalization of 11–28% for expenditure measures of public services and 5–16 % when PSI is used in a regression. The same conclusion was reached in chapter 3 using variations in the Oates' methodology.

King (1977) and Reinhard (1981) did not distinguish between intrajurisdictional and interjurisdictional aspects of tax capitalization as their data did not provide an opportunity for this test. We investigate this possibility in the next section.

Table 4.3
A SUMMARY OF CAPITALIZATION RESULTS

<u>Assumptions</u>:
A. ($r=.02$, $i=40$)
B. ($r=.02$, i(structure)$=40$; i(land)$=\infty$)
C. ($r=.02$, $i=\infty$)
D. ($r=.05$ $i=\infty$)

EQUATION	METHOD	Residential Property Taxes (%) A	B	C	D	Local Public Expenditures (%) A	B	C	D
4.11	RLS	186	140	102	255	20	15	11	28
4.12	TSLS	181	136	99	247	20	15	11	27
4.13	Non-Linear	222	167	121	303	20	15	11	27
4.14	RLS	177	133	97	242	12	9	6	16
4.21	RLS	174	130	95	237	10	7	5	14
4.22	Non-Linear	188	141	102	257	10	8	6	14
King (1977)	TSLS	63	47	34	85				
Reinhard (1981)	TSLS	91	68	49	122				

4.3 PUBLIC SECTOR CAPITALIZATION WITHIN AND ACROSS JURISDICTIONS

To investigate public sector capitalization both within and across jurisdictions based on the King-Reinhard method the basic estimating equations are respecified as follows:

$$P+(b_1/r)\ \mathrm{TAXDIF} + (b_2/r)\ \mathrm{MTAX} + (b_3/r)\ \mathrm{TAXDIF24} + (b_4/r)\ \mathrm{MTAX24}$$

$$= \alpha_0 + \Sigma\beta_i X_i \qquad (4.31)$$

where MTAX = municipal mean property tax per household ($)

TAX = house property tax bill ($)

TAXDIF = TAX − MTAX

TAXDIF24 = (TAXDIF)(D24)

MTAX24 = (MTAX)(D24)

The above equation can also be written as :

$$P(1+(b_1/r)(t-mt)+(b_2/r)mt+(b_3/r)(t-mt)D24 +(b_4/r)mt.D24) = \alpha_0 + \Sigma\beta_i X_i \qquad (4.32)$$

Alternately

$$P = (\alpha_0 + \Sigma\beta_i X_i)/ (1+(b_1/r)(t-mt)+(b_2/r)mt+(b_3/r)(t-mt)D24 +(b_4/r)mt.D24) \qquad (4.33)$$

where t = house effective tax rate

mt = municipal effective tax rate

Tables 4.4 and 4.5 present the results following the specifications of the capitalization equation as in 4.31 and 4.33. Three sets of these equations are estimated. The first set contains variables in their original form. In the second set LOCAL is replaced by PSI and in the third set, composite indexes are used in place of structure , site and public services characteristics. The estimation procedures described in Section 4.1 are followed. The restricted least squares (RLS) results of equation 4.41 show smaller coefficients for all public sector variables than those obtained in non-linear estimation (equation 4.42). Replacement of LOCAL by PSI leads to smaller coefficients for the remaining tax

Table 4.4
PUBLIC SECTOR CAPITALIZATION ESTIMATION BASED ON MODIFIED KING-REINHARD APPROACH I
(875 Observations)

EQUATION	4.41	4.42	4.43	4.44
METHOD	RLS	Non-Linear	RLS	Non-Linear
INTERCEPT	-27571	-27361	3749.6	3711.7
	(-2.6)	(-4176.1)	(0.9)	(84.3)
ROOMS	1039.4	1067.1	542.8	596.7
	(2.1)	(83.7)	(1.2)	(25.5)
DSIZE	23.3	25.7	21.1	23.8
	(14.6)	(9.0)	(13.7)	(9.9)
LRA	58.2	56.8	51.2	50.9
	(6.3)	(5.8)	(5.8)	(5.7)
AGE	-255.5	-231.5	-290.6	-267.0
	(-7.4)	(-5.8)	(-8.7)	(-8.2)
FP	2550.5	2545.1	1910.1	2528.3
	(1.7)	(294.4)	(1.4)	(27.1)
DFR	4491.2	4484.7	3457.0	4420.7
	(4.5)	(407.5)	(3.6)	(14.1)
BATH	2142.2	2149.2	2183.3	2157.7
	(2.1)	(177.0)	(2.2)	(31.1)
GAR	3829.1	3834.6	3789.5	3837.8
	(4.5)	(393.0)	(4.7)	(116.2)
BRST	10633.	10631.	9709.5	9633.8
	(4.3)	(2670.9)	(4.1)	(1565.7)
LSIZE	4.3	4.4	3.9	4.0
	(10.1)	(8.2)	(9.6)	(8.3)
GAI	37.0	14.7	28.3	20.5
	(1.5)	(0.7)	(1.5)	(1.1)
Y	184.5	165.7	210.1	243.9
	(1.1)	(1.1)	(1.3)	(1.8)
TAXDIF	-51.3	-57.8	-48.7	-50.6
		(-8.1)		(-8.2)
MTAX	-20.7	-48.5	-41.5	-52.8
		(-3.0)		(-4.2)
TAXDIF24	-22.6	-71.7	26.3	-91.2
		(-1.7)		(-2.3)
MTAX24	-10.4	-22.7	-18.5	-29.8
		(-2.9)		(-3.8)
LOCAL	20.4	32.6		
	(1.8)	(8.6)		
PSI			9211.4	9216.5
			(8.4)	(260.2)

(Continued...)

Table 4.4(Continued)
PUBLIC SECTOR CAPITALIZATION ESTIMATION BASED ON MODIFIED KING-REINHARD APPROACH I
(875 Observations)

EQUATION	4.41	4.42	4.43	4.44
R^2	.6056		.6329	
S.E.E.	15695		14945	
LF		-9375.1		-9339.2

Table 4.5
PUBLIC SECTOR CAPITALIZATION ESTIMATION BASED ON MODIFIED KING-REINHARD II

EQUATION	4.51	4.52
Method	RLS	Non-Linear
INTERCEPT	32402.	29945.
	(15.1)	(1006.0)
STRUCI	29698.	25877.0
	(26.6)	(56.0)
SITEI	11471	10284
	(10.4)	(27.3)
Y	118.6	177.5
	(0.8)	(1.8)
PSI	7804.7	6661.2
	(7.5)	(9.4)
TAXDIF	-47.8	-41.8
		(-9.7)
MTAX	-37.5	-19.9
		(-7.8)
TAXDIF24	-28.7	-66.2
		(-2.0)
MTAX24	-17.0	-25.4
		(-4.1)
R^2	.6297	
S.E.E.	14858	
LF*		-9340.9

variables than those obtained in equation 4.41. It also improves the overall explanatory power of the equation as revealed by R^2 and S.E.E in RLS and by log-likelihood function in non-linear estimation. Non-linear estimation of equation 4.44 also shows improvement in t-ratios and thereby precision of estimates for tax variables.

Finally we replaced structure, site and public services variables by their respective composite indices. The results are reported in Table 4.5. Smaller coefficients for TAXDIF are now obtained by using the RLS and non-linear methods than those reported in Table 4.4. The coefficient of MTAX obtained in non-linear estimation 4.52 is also smaller than those derived in earlier regressions. TAXDIF24 and MTAX24 show an intermediate range compared to the coefficients reported for the same variables in earlier runs. The explanatory power of this model using RLS is slightly superior to the RLS estimation in earlier runs. The precision of estimates for tax variables in equation 4.52 is also higher than obtained in equation 4.44. Overall fit of the model as evidenced by the log-likelihood function is marginally better in 4.44 as compared to 4.52.

The level of capitalization indicated by these regressions is the focus of next section.

4.4 THE EXTENT OF PUBLIC SECTOR CAPITALIZATION WITHIN AND ACROSS JURISDICTIONS

Results reported in Tables 4.4 and 4.5 indicate that both intra and inter-jurisdictional property tax capitalization influences are quite strong in the sample communities. Also both the impacts are distinctly stronger in the City of St. Albert as compared to other sample communities. Public sector capitalization results for the sample communities are summarized in Table 4.6. For r=.02 and i=40 intrajurisdictional capitalization estimates range from 153 to 211% and interjurisdictional capitalization from 73 to 193%. The lower limits of these ranges in both cases are obtained when the three composite indices are used. If, however, we assume r=.02 and i= ∞ , within jurisdiction capitalization estimates are in the range of 84-115% and across jurisdiction capitalization between 40-105 %. An intermediate capitalization range is indicated for both the influences under assumption B (see Table 4.6). Overcapitalization of taxes is suggested under assumption D (r=.05 and i= ∞).

Table 4.6
CAPITALIZATION RESULTS USING MODIFIED KING-REINHARD APPROACH

Assumptions:
A. (r=.02, i=40)
B. (r=.02, i(structure)=40, i(land)= ∞)
C. (r=.02, i= ∞)
D. (r=.05 i= ∞)

EQUATION	4.41	4.42	4.43	4.44	4.51	4.52
Method	RLS	Non-Linear	RLS	Non-Linear	RLS	Non Linear
RESIDENTIAL PROPERTY TAX CAPITALIZATION(%)						
A. Intrajuris.						
1. A	187	211	178	185	175	153
2. B	141	159	134	139	131	115
3. C	102	115	97	101	96	84
4. D	256	289	243	253	239	209
B. Interjuris.						
1. A.	76	177	152	193	137	73
2. B.	57	133	114	145	103	55
3. C.	41	97	83	105	75	40
4. D	103	242	207	264	187	99
LOCAL PUBLIC EXPENDITURE CAPITALIZATION						
1. A.	22	35	12	12	10	8
2. B.	16	26	9	9	7	6
3. C.	12	19	6	6	5	5
4. D.	30	48	16	16	14	12

The regression results reported in Section 4.3 also indicate a small degree of public expenditure capitalization. The use of expenditure measure of public services output indicates a range of 22 to 35 % whereas the use of output index PSI indicates a range of 8 to 12 % expenditure capitalization under assumption A.

4.5 AN OVERVIEW OF CAPITALIZATION RESULTS

A comprehensive summary of capitalization results obtained in this study is presented in Table 4.7. The empirical evidence is overwhelmingly in favour of complete capitalization of residential property taxes and only partial capitalization of local expenditures. A range of 79 to 121 % for tax and 3 to 12 % for expenditure capitalization is suggested under assumption C and using alternate models. The results also suggest a stronger degree of capitalization of intrajurisdictional tax differentials than interjurisdictional differentials . Although the precise estimates vary according to the model selected, the econometric technique used and the assumptions regarding the discount rate and the time horizon, overall conclusions are consistent. Also broadly consistent conclusions are reached using alternate approaches suggested by Oates, King and Reinhard.

The use of a quality index of public services leads to more precise capitalization estimates although the general conclusions derived from the use of expenditure measures of public services output are sustained. A very small degree of public expenditure capitalization also implies that the provision of local public services in Edmonton may not be consistent with efficiency. We will carry out a more direct empirical test of this question in the next section.

4.6 IMPLICATIONS OF CAPITALIZATION FOR EFFICIENT PROVISION OF LOCAL PUBLIC GOODS

In the following , implications of capitalization for efficient provision of local public goods in Metropolitan Edmonton are drawn based on an empirical test for allocative efficiency suggested by Brueckner (1979,1982) and a balanced budget approach.

Table 4.7
CAPITALIZATION RESULTS: A COMPREHENSIVE SUMMARY

		RES. PROP. TAXES(%)			
EQUATION	METHOD	OVERALL Range*	INTRA JURIS DIC. Range*	INTER JURIS DIC. Range*	LOCAL PUB. EXP. Range* (%)
	I A				
3.11	OLS	96-228			8-20
3.12	TSLS	88-208			8-20
3.13	Box-Cox				
	(λ =-.15)	90-212			4-11
	I B				
3.14	OLS	81-192			5-13
3.15	Box-Cox				
	(λ =-.13)	82-194			5-12
	I C				
3.61	OLS	79-186			4-11
3.62	Box-Cox				
	(λ =0)	85-200			4-10
	II A				
3.101	OLS		75-182	15-37	9-22
3.102	Box-Cox				
	(λ =-.68)		47-115	11-28	1-3
	II B				
3.103	OLS		63-153	76-181	5-13
3.104	Box-Cox				
	(λ =-.62)		44-107	78-184	3-6
	II C				
3.121	OLS		61-147	66-157	4-11
3.122	Box-Cox				
	(λ =-.42)		52-126	47-111	3-7
	III A				
4.11	RLS	102-225			11-28
4.12	TSLS	99-247			11-27
4.13	Non-Linear	121-303			11-27
	III B				
4.14	RLS	97-242			6-16
	III C				
4.21	RLS	95-237			5-14
4.22	Non-Linear	102-257			6-14

(Continued...)

Table 4.7 (Continued)
CAPITALIZATION RESULTS: A COMPREHENSIVE SUMMARY

		RESIDENTIAL PROPERTY TAXES (%)			
EQUATION	METHOD	OVERALL Range*	INTRA JURIS DIC. Range*	INTER JURIS DIC. Range*	LOCAL PUB. EXP.% Range*
	IV A				
4.41	RLS		102-256	41-103	12-30
4.42	Non-Linear		115-289	97-242	19-48
	IV B				
4.43	RLS		97-243	83-207	6-16
4.44	Non-Linear		101-253	105-264	6-16
	IV C				
4.51	RLS		96-239	75-187	5-14
4.52	Non-Linear		84-209	40-99	5-12
ALL METHODS (under assumption C only)		79-121	44-115	40-105**	3-12**

* The lower limit of this range obtains under assumption C
**ignores II A

4.6.1 Brueckner's Approach

In chapter 1 we presented Brueckner's theoretical result that an inverse relationship between public services and residential property values is a definite indicator of overprovision of local public goods beyond optimal levels. We noted that Brueckner's empirical analysis was weak due to inadequate data for the problem at hand. A stronger empirical test of efficiency of local public goods based on Brueckner's theoretical model can be carried out using the detailed data assembled for this study. Our data also enables us to draw public sector efficiency implications for each of the sample communities.

The following estimating equation follows closely Brueckner's empirical formulation.

$$\begin{aligned} P = \alpha_0 &+ \beta_1 \text{ ROOMS} + \beta_2 \text{ DSIZE} + \beta_3 \text{ LRA} + \beta_4 \text{ AGE} + \beta_5 \text{ FP} \\ &+ \beta_6 \text{ DFR} + \beta_7 \text{ BATH} + \beta_8 \text{ GAR} + \beta_9 \text{ BRST} \\ &+ \beta_{10} \text{ LSIZE} + \beta_{11} \text{ DCBD} + \beta_{12} \text{ POOR} + \beta_{13} \text{ Y} \\ &+ \beta_{14} \text{ POP} + \beta_{15} \text{ NRA\%} + \beta_{16} \text{ OLD} + \beta_{17} \text{ LOCAL} \\ &+ \beta_{18} \text{ LOCAL24} + \beta_{19} \text{ LOCAL25} + \beta_{20} \text{ LOCALA} \\ &+ \beta_{21} \text{ LOCALB} \end{aligned} \qquad (4.61)$$

The following variables are appearing for the first time in equation 4.61. The remaining variables have been defined earlier.

POOR = % of families having income below $12,000

and differential LOCAL slope dummies for:

St. Albert (LOCAL24)

Sherwood Park (LOCAL25)

Spruce Grove, Leduc and Fort Saskatchewan (LOCALA);

and Morinville, Stony Plain and Devon (LOCALB).

It may be noted that Brueckner used ROOMS and OLDAGE HOUSING as structural characteristics. ROOMS is retained in equation 4.61. OLDAGE HOUSING is replaced by AGE. Several other structural variables have been added. DCBD, POOR, Y and POP have

been retained. Brueckner used SALES as a proxy for business profits. In our sample NRA% (non-residential assessment/total assessment) serves as a better proxy for business profits.

To carry out a stronger test of equality of regression coefficients for public sector variables than is available with the help of a Chow test[4], we introduce differential slope dummies for communities in our sample. Individual dummies are used for communities having 1977 population greater than 25,000. The communities having 1977 population of 7,000 – 10,000 and those having population of 2,000 3,000 are grouped and assigned seperate dummy variables. Thus regression results would enable us to discuss if the sample communities' performance in the provision of local public goods differs in any significant manner among these groups.

Table 4.8 presents regression results for equation (4.61). As the results using both OLS and TSLS were essentially equivalent, only the TSLS results are reported. All the structural characteristics have statistically significant coefficients at least at the .05 level with correct signs. As expected LSIZE and Y appear with positive significant coefficients (.05 level) and DCBD and POOR with negative significant coefficients (at .10 and .05 respectively). NRA% has a positive coefficient but it is not statistically significant coefficient at the .05 level. The theory is ambigous about the sign of coefficients for POP and OLD. Both appear with negative signs which are not statistically significant at the .05 level. The coefficients for LOCAL , LOCAL24 and LOCAL25 are negative whereas for LOCALA and LOCALB are positive. The former three coefficients are, however, not statistically different from zero. LOCALA and LOCALB are positive and significant at the .25 level only.

The coefficients of LOCAL and differential slope dummies for LOCAL imply that the marginal net impact of the local public sector on residential property values is negative (but statistically not different from zero) in Edmonton, St. Albert and Sherwood Park. For smaller communities this marginal net impact is positive and statistically significant at the .25 level only. Thus the regression results suggest a weak tendency to overprovide local public goods in Edmonton, St. Albert and Sherwood Park only.

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[4]See Maddala (1977) pp.198–199, 131–141.

Table 4.8
AN EMPIRICAL TEST OF THE EFFICIENCY OF LOCAL PUBLIC SECTOR
IN METROPOLITAN EDMONTON
(875 Observations)
Dependent Variable = P

VARIABLES*	COEFFICIENTS	t-VALUES
ROOMS	661.46	1.7808
DSIZE	16.267	13.369
LRA	44.897	6.4081
AGE	-171.7	-6.442
FP	2757.3	2.4677
DFR	3672.7	4.8169
BATH	987.99	1.2702
GAR	3112.8	4.8246
BRST	6946.8	3.7091
LSIZE	2.5664	7.9680
DCBD	-620.8	-1.312
POOR	-267.7	-2.823
Y	0.9173	3.4257
POP	-0.0060	-0.091
NRA%	53.168	0.2685
OLD	-121.8	-0.229
LOCAL	-5.658	-0.3402
LOCAL24	-1.840	-0.2193
LOCAL25	-0.872	-0.156
LOCALA	8.7675	1.0582
LOCALB	10.759	1.0008
INTERCEPT	14215.2	0.6758

R^2 = 0.5887
Standard Error of the Estimate: 11864
*PCEA, BAPC, PPD, PGR, RPK and MG were used as instrumental variables in TSLS estimation

An alternate approach is used in the next section to test for efficiency of local public goods provision in Metropolitan Edmonton.

4.6.2 A Balanced Budget Approach to Test the Efficiency of Local Public Goods Provision

The regression results presented in chapters 3 and 4 enable us to carry out a simpler test of the efficiency of local public goods provision than the one advocated by Brueckner (1979). This can be done by estimating the impact on house price of a dollar increase in per capita local expenditure financed solely by residential property taxes (Δ P/ Δ LOCAL). As the average size of a household according to the 1976 Census is 3.4 , a balanced budget dollar increase in per capita expenditure would require $3.4 increase in residential property tax per household.

The application of a balanced budget approach outlined above would be more appropriate for regressions which estimate capitalization of both within and across jurisdictions tax differentials as the approach requires incorporating the independent influence of inter-jurisdictional tax capitalization only. These were identified as the Oates II and King-Reinhard II approaches in chapters 3 and 4 respectively. It may be recalled that the King-Reinhard II approach uses tax burden variables and , therefore, Δ P/ Δ LOCAL could be calculated in a straightforward manner. The calculations are based on the metropolitan Edmonton sample values and are reported in Table 4.9 (see equations 4.41 through 4.52).

To carry out the same calculations for regressions using the effective tax rate variable (Oates II), the following simple model is utilized.[5]

Consider the following regression equation :

$$P = \mathring{\alpha}_1 + \hat{\alpha}_2 \text{ LOCAL} - \hat{\alpha}_3 t + \hat{\alpha}_4 X \qquad (4.62)$$

$$\hat{\alpha}_i > 0$$

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[5]Professor Dahlby suggested this formulation.

Table 4.9
ESTIMATES OF A CHANGE IN AVERAGE HOUSE PRICE AS A RESULT OF A DOLLAR INCREASE IN PER CAPITA EXPENDITURE FINANCED SOLELY BY RESIDENTIAL PROPERTY TAXES

EQUATION	$\Delta P / \Delta$ LOCAL 68.26 % Confidence Interval			$\Delta P / \Delta$ LOCAL Average	IMPLICATION
Oates II					
3.101	(-18.6)	-	(+11.8)	-3.4	?
3.102	(-23.4)	-	(-0.3)	-11.9	overprovision
3.103	(-119.4)	-	(-41.9)	-80.9	overprovision
3.104	(-126.3)	-	(-43.9)	-88.9	overprovision
3.121	(-102.4)	-	(-37.8)	-70.1	overprovision
3.122	(-79.0)	-	(-21.3)	-50.2	overprovision
King-Reinhard II					
4.41		-50.0*		-50.0	overprovision
4.42	(-187.4)	-	(-77.2)	-132.3	overprovision
4.43		-130.2*		-130.2	overprovision
4.44	(-182.9)	-	(-154.3)	-168.6	overprovision
4.51		-118.3*		-118.3	overprovision
4.52	(-86.3)	-	(-133.2)	-59.8	overprovision

*The coefficient was constrainted to optimal value.Therefore, confidence interval could not be calculated.

If $\tau A_i = (TAX)_i$ = Tax payment on property i

where τ = Nominal tax rate

A_i = Assessed value of property i.

Then $t_i = \tau(A_i/P_i)$

$$\text{And} \quad TAX = \sum_{i=1}^{n} (TAX)_i$$

$$\Delta LOCAL(POP) \cong \Delta\tau\Sigma A_i$$

$$\Delta\tau = \Delta LOCAL(POP/\Sigma A_i)$$

$$\Delta t_i = \{ (\Delta LOCAL)(POP/\Sigma A_i)(A_i/P_i) \}$$

$$\Delta P_i = \alpha_2 \ (\Delta LOCAL) - \alpha_3 \Delta t_i$$

$$\Delta P_i = \alpha_2 \ (\Delta LOCAL) - \alpha_3 (\Delta LOCAL)(POP/\Sigma A_i)(A_i/P_i)$$

$$\therefore (\Delta P_i)/(\Delta LOCAL) = \left[\alpha_2 - \alpha_3 \{ (A_i/P_i)/(\Sigma A_i/POP) \}\right] \tag{4.63}$$

Equation 4.63 shows the effect of an increase in expenditure of one dollar per capita financed through a residential property tax.

Table 4.9 presents estimates of a change in average residential property value as a result of a dollar increase in per capita expenditure financed solely by residential property taxation. The estimated average impact is a decrease ranging from a low of $3.4 to a high of $168.6 in average house price. The average decrease is $51 using Oates approach and $110 based on King-Reinhard II. The table also reports 68% confidence interval for estimates of Δ P/ ΔLOCAL. Only equation 3.101 shows a positive value for Δ P/ Δ LOCAL at the upper limit of this confidence interval. This estimate , however, is an outlier. Thus overall results of Table 4.9 reinforce our conclusions reached in the earlier section regarding overprovision of local public goods in metropolitan Edmonton.

4.7 CONCLUDING REMARKS

The following paragraphs outline the empirical procedures used and sum up the capitalization findings of this study and discuss their implications in the light of the Tiebout literature.

Empirical tests of the capitalization hypothesis were performed using alternate approaches suggested by Oates (1969,1973), King (1977) and Reinhard (1981). These approaches differ as to the use of the property tax variable in determining the degree of tax capitalization. Oates advocated use of the effective tax rate whereas King and Reinhard favoured the property tax bill per household. We extended these approaches to investigate both intra and inter-jurisdictional tax capitalization. Contrary to most earlier studies on the subject, we utilized house-specific sales data and investigated capitalization of tax-service package differentials both within a jurisdiction and across jurisdictions. Careful attention was paid to econometric estimation problems. The hedonic price function was estimated embodying a generalized functional form. The simultaneity bias, the heteroskedasticity, the multicollinearity and the non-linearity problems were discussed. As a possible solution to the multicollinearity problem encountered in this study, thirty-five canonical indices representing composite public services output characteristics for twenty-seven communities within the city of Edmonton and eight neighbouring municipalities were formed. These indices proved useful in deriving improved estimates of public sector capitalization within and across the sample municipalities.

In investigating public sector capitalization based on the effective tax rate variable (the Oates approach) we estimated thirteen equations using a variety of models and data. Of these models equation 3.103 appears to be most satisfactory based on theoretical considerations and empirical results. It distinguishes between intra- and inter-jurisdictional aspects of property tax capitalization. It also incorporates quality indices for public sector output which are theoretically preferrable over expenditure measures. Moreover, these measures are neighbourhood specific as opposed to expenditure measures of public services which are only available at the municipal jurisdiction level. Empirically, the equation overcomes the multicollinearity problem by incorporating a composite measure of public services which is not collinear with other

regressors. All the independent variables appear with statistically significant coefficients having sizes and signs consistent with priori expectations.

Equation 3.103 is being preferred over equations 3.104 and 3.122 for two reasons. First, although the latter equations embodied generalized functional form, the magnitude of the public sector capitalization indicated by equation 3.103 was more consistent with our expectation. Second, the coefficients of the chosen equation are linear and thus easily understood and amenable to further analysis.

As an alternate approach to tax capitalization, we also estimated models using the annual property tax bill ($) per household as an explanatory variable (the King– Reinhard approach). These models also differed as to the choice of public sector variables and econometric technique employed. Of these models, equation 4.52 presents superior results than alternate estimating equation.

Recall that the model incorporating the King–Reinhard suggestions is non–linear both in variables and parameters. Equation 4.52 estimated this model by non–linear method based on a Quasi–Newton algorithm. This procedure enabled us to obtain more precise estimates of all regressors without encountering the heteroskedacticity problem often encountered with the use of iterative linear methods. Furthermore, the equation utilized composite indices of structure, site and public services characteristics and thus a very small set of significant regressors explained most of the variations in the house price. All the regressors appear with the expected signs. Like equation 3.103 it also enables us to estimate the extent of both within and across jurisdiction tax capitaliztion.

Assuming a disount rate of 2% and a life of 40 years for the structural component and an infinite time horizon for the land component of the house value, the following capitalization conclusions are suggested by the equations 3.103 and 4.52.

Tax Capitalization

a. *Intrajurisdictional*

Estimation incorporating an extension of the Oates' approach suggests 87% capitalization of random assesment differentials within jurisdictions. The modified King–Reinhard approach would place the same figure at 115%.

b. *Interjurisdictional*

The extended Oates approach indicates 99% capitalization whereas the modified King–Reinhard methodology suggests 55% of across jurisdiction tax differentials are capitalized.

Expenditure Capitalization

A range of 6 to 7% capitalization of local public expenditures is suggested by the two alternate approaches.

It may be noted that we reach broadly consistent capitalization conclusions using alternate approaches. Our results are inconsistent with Oates (1963, 1973) who finds significantly large capitalization of school and municipal expenditures. But our results are consistent with Noto's (1976a, 1976b, 1976c) study for San Mateo County, California. She found complete or over–capitalization of property taxes, no significant capitalization of muncipal expenditures and a small degree of capitalization (less than 10%) of school expenditures. [6]

Low expenditures capitalization may have occured due to several reasons.

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[6] Markusen(1976) views Noto's results "as support for a Marxist srgument that surburban location is a phenomenon of class, rather than individual, interests. The major function of the local public sector isnot the efficient production of public sector services but the maintenance of the class nature of the community by using public sector structure to keep out other proups" (p. 204).

1. The public services index (PSI) accounts for variations in 'soft' services (police and fire protection, education, public transit and parks and recreation) only. Simon argues that these services are valued at less than their dollar cost and hence inexactly capitalized. This is because the householder perceives expenditure on 'hard' or property-oriented services say street construction as merely compensation for the purchase of a direct service to his property which enhances its value commensurably whereas, Simon asserts, he is unlikely to weigh 'soft' services in the same manner.[7]

   This argument may have some relevance to our study as the expenditure measures of public services output accounted for all services and yielded somewhat greater capitalization. Serious reservations were ,however, expressed about the suitability of these measures of public output on theoretical and empirical considerations.

2. The extent to which local public expenditure is capitalized depends upon the elasticities of demand and supply in the housing market. If the supply of housing is completely inelastic, the public expenditure if valued at full cost, would be completely capitalized (except for the case of perfectly inelastic demand). On the other extreme, if the supply of housing was perfectly elastic, any shift in the demand curve would not have any impact on the observed selling price, hence, there will be no expenditure capitalization.[8]

   We observe that the supply of housing is not completely inelastic in the study area. Some vacant land is available. Possibilities also exist to vary the supply of housing by changes in the type of housing. Furthermore, annexation has often been used to

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[7] See Simon (1943a) p. 3 and p. 14. Marshall (1936) and Pollakowski (1972) use the same arguement although they use slightly different terminology. The 'hard' services (sewage, water, etc.) are called 'beneficial' by Marshall and 'normal' by Pollakowski and hypothesized to be fully capitalized. See Noto (1976a, 1976b, 1976c) and Boskin (1973).

[8] An alternate therotical explanation for no expenditure capitalization given by Noto (1976c) is that there may be different elasticities of demand for individual housing attributes. She stated:

> "For any rightward shift in the housing supply curve, there will be greater price discount for characteristics subject to inelastic demand curves than elastic one. Characteristics which are in plentiful supply or are easy to produce such as structure characteristics and possibly public services expenditures are likely to face quite elastic demand curves" (p. 199).

redraw jurisdictional boundaries in the region.

3. *Econometric Issues:*

The property tax variable is house specific and is not subject to any measurement error. Public services on the other hand are represented by proxies and are aggregated to community level. The expenditure measures of these services incorporate all services but do not distinguish sub-areas within a jurisdiction. Thus dP/dLocal is across many homes in a given jurisdiction and thereby reflects a significant large change in the supply of homes with a given level of per capita local expenditure. The public services index (PSI) offers some improvement over LOCAL in this regard. For example, it captures some intracommunity services variations within the City of Edmonton. We had 35 observations on PSI (27 for Edmonton and 8 for other communities) as opposed to only 9 for LOCAL. Its major limitation , however, is that it is based on 'soft' services only. Furthermore, much is lost in its translation into dollar values as the relationship between PSI and LOCAL is found to be very weak. Thus major difficulties associated with specifying and then gathering data on variables to adequately describe the local public sector environment still remain.

Empirical results for the models investigating tax capitalization within and across jurisdictions cast a considerable shadow of doubt on the argument that these limitations may have, in large part, been responsible for the small degree of expenditure capitalization. The Oates II and King-Reinhard II models have only 9 observations on tax variables, MT and MTAX, and 35 observations on PSI, yet taxes are exactly capitalized whereas services capitalization is inexact. This brings us to the following theoretical basis of this differential capitalization.

4. *Taste Differences For Public Output:*

Yinger (1982) demonstrates that when sorting of communities by income and taste occurs, tax differences are exactly capitalized whereas public services

variations are inexactly capitalized. This happens because the observed differences in property values $\left\{P(LOCAL, T^*)\right\}$ between say a rich and poor community "does not (accurately) measure the valuation of either rich or poor households of differences in service levels between the two jurisdictions" (Yinger 1982, p. 925). Property tax rates on the other hand are exactly capitalized into house values and the observed differences in housing prices $\left\{P(LOCAL^*, T)\right\}$ across communities do exactly reflect willingness to pay for tax rates regardless of the number of income-taste classes.

The above argument, however, is not applicable for our study as the differences in tastes explain the failure to fully capitalize expenditures best if there are a few distinct taste classes, e.g. rich and poor. On the other hand, we believe our study area represents a continuum of taste classes. Thus a substantial amount of capitalization (though imperfect) should still occur.

5. *Overprovision of Local Public Services:*

Finally, very small expenditure capitalization may be due to overprovision of local public services in the study area. Intergovernmental transfers constitute a significant source of revenue for local government in Alberta. For example, in 1978 Alberta grants (municipal and school operating and capital grants) accounted for 33.3 per cent whereas residential properety taxes only 12.4 per cent of local government gross revenues in Alberta.[9]

The presence of generous provincial transfers to local governments in the region distorts consumer preferences and the median voter opts for the levels of local public services beyond those dictated by efficiency considerations alone.[10]

This probably is the most important reason for low expenditure capitalization in the study region and is supported by the empirical tests of efficiency of local public goods provision in the Edmonton metropolitan area presented in this chapter.

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[9] See Chaudry (1980a). For an econometric analysis of the impact of Provincial transportation assistance on local fiscal behaviour, see McMillan, Chaudry and Gillen (1980).

[10] Starret (1980) demonstrates that communities having access to non-property tax revenues will overexpand and overprovide public goods relative to the first best optimum.

Recall that the implications of capitalization for efficient provision of local public services in the study area have been drawn based on a property value determination model suggested by Brueckner (1979) and a balanced budget approach. Both these approaches suggest a tendency on the part of major local governments in the metropolitan region to overprovide local public goods. The former approach arrives at this conclusion by observing a non-positive net impact of the local public sector on housing prices whereas the latter approach bases these findings on the estimated net negative change in the average residential property value as a result of a dollar increase in per capita expenditure financed solely by residential property taxes.

We conclude this chapter with the remarks that our findings of exact capitalization of taxes and inexact capitalization of expenditures are consistent with the theory and would be expected for the study area when proper consideration is given to the underlying economic conditions in this area.

5. REDISTRIBUTION THROUGH THE LOCAL PUBLIC SECTOR IN EDMONTON

5.1 INTRODUCTION AND AN OVERVIEW OF APPROACHES TO FISCAL INCIDENCE

Musgrave and Musgrave (1980)[1] classify budgetary activities of governments in three broad categories; namely

1. the public provision of certain goods and services ;
2. adjustment in the distribution of income ; and
3. measures to achieve economic stabilization and economic growth .

Only the first function is assigned a major priority at the local government level. However, the budgetary activities of local governments affect economic positions of individuals in their jurisdictions. To quantify the distributional effects of the local government's economic activities in the City of Edmonton is the focus of this chapter. To this end, it would be helpful first to present a brief overview of the approaches to fiscal incidence.

During the past two decades several important studies have been published which investigate the redistributive implications of federal, provincial and local government finances in Canada. [2] All the Canadian studies on the subject in general follow the methodology used for similar studies in the U.S. These studies differ as to the shifting of tax burden assumptions and the concept of income employed and understandably their results also vary accordingly. A major common criticism of these approaches is that their "distribution conclusions depend crucially on what incidence hypothesis is chosen." [3] Bird and Slack (1978) [4] correctly note that all these studies merely illustrate what the distribution of fiscal incidence would be if the incidence assumptions were true. The numerical estimates thus derived have limited significance although they are often used to support the assumptions from which they are derived.

Musgrave, Case and Leonard (1974), for example, illustrate property tax incidence using broad income (money income plus accrued asset gains) as a measure of income and

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[1]See Musgrave and Musgrave (1980),p.22.
[2] See Ross (1980) and Reuber (1978) for summaries of Canadian studies on fiscal incidence. See also Ballentine, Thirsk and Dean (1978), Gillespie (1965,1966,1976) and Toronto Social Planning Council (1979).
[3] Musgrave and Musgrave (1980),p.394
[4] See Bird and Slack (1978),pp.152–154.

assuming that the tax on owner-occupied housing is borne by owners and on rental housing by tenants; and non-residential portion of the tax is shifted one-half to consumers and one-half borne by all asset holders in proportion to capital income (the 'traditional' incidence hypothesis). Using these assumptions they find support for the 'traditional view' of the property tax incidence i.e. the tax is regressive. However, when the allocation basis is changed and all property taxes are allocated in proportion to total income from capital then they find support for the 'new view' i.e. the incidence of the local real property tax is progressive . Figure 5.1 from Bird and Slack (1978) succintly summarizes the uncertain state of the art of the incidence of the real property tax.[5] The figure illustrates that the tax incidence will be regressive if we employ traditional incidence assumptions (A & D) and progressive if our incidence hypothesis corresponds to the 'new view' (assumptions B,C & E).

The approaches to benefit incidence are no less controversial . Gillespie (1965) pioneered the reasonable assumptions approach to benefit incidence. This approach identifies beneficiary groups for each public good and then makes reasonable assumptions as to the distribution of benefits using one or more concepts of income. Aaron and McGuire (1970) sought to improve upon Gillespie's work by deriving benefit allocation implications for public goods by postulating a utility function and placing reasonable restrictions on it. [6] They theoretically establish the rule that imputed benefits of public goods should be allocated in inverse proportion to the marginal utility of income. At first it was thought that the elasticity of marginal utility of income could be estimated and researchers used as a proxy for this magnitude the reciprocal value of the overall elasticity of substitution among consumer goods. Based on Powell (1965) [7] Maital placed an estimate of the elasticity of marginal utility of income for Canada at 1.55. It followed that the imputed benefits from public goods increase faster than income and hence the provision of public goods operates to make income distribution less equal. Maital (1975) [8] using 1960 data for the U.S. demonstrates that the distribution of net fiscal incidence will be pro-poor if Gillespie's methodology is followed and pro-rich if

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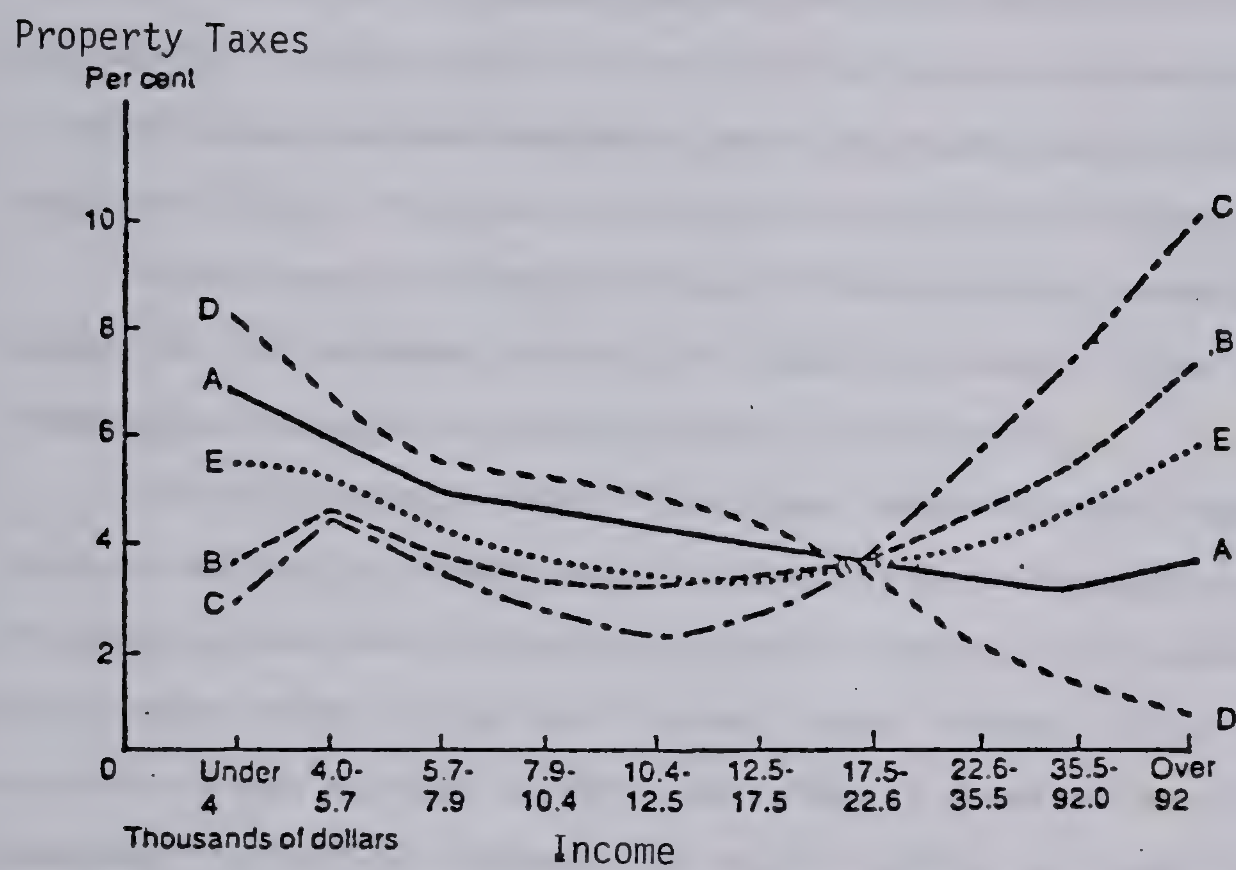
[5] See Bird and Slack (1978),p.154.
[6] Aaron and McGuire assume (i) identical preference maps for all individuals; (ii) utility functions additively seperable in public and private goods; (iii) output of public goods is efficient; and (iv) perfect information.
[7] See also Sato (1972).
[8] See also Maital (1973),pp.561-68 and Greene, Neenan and Scott (1974, 1976).



Assumptions
A Non-residential (1/2 consumers, 1/2 capital income); residential (homeowners, renters)
B Non-residential and rental residential (capital income); owner occupied (homeowners)
C All (capital income)
D Non-residential (consumers); residential (homeowners, renters)
E Non-residential (capital income); residential (homeowners, renters)

Source: Bird and Slack (1978)

Figure 5.1 PROPERTY TAXES AS A PERCENTAGE OF TOTAL INCOME
(UNITED STATES 1968)

the Aaron and McGuire approach is adopted. Neenan (1972) proposed that the elasticity of the marginal utility of income could be inferred from empirical studies on the determinants of public expenditures and the demand for public goods. [9] From a review of these studies , he concluded that the benefits from public goods are distributed proportionally to income.

The Aaron and McGuire approach was initially thought to be superior to Gillespie's approach as it provided a more rigorous framework for empirical estimation. Brennan (1976) , however, quite persuasively argued and Aaron and McGuire (1976) agreed that the elasticity of marginal utility of income could not be empirically estimated. Ballentine et al. (1978) discuss alternate assumptions under which both the approaches reach similar conclusions. Table 5.1 highlights these similarities using alternate incidence hypotheses.

Without going into a detailed critique of the approaches to benefit incidence , it is obvious that the accepted doctrines are equally imprecise as those adopted for tax incidence due to the use of highly discretionary procedures. [10]

The two broad approaches [11] discusssed above have been applied to federal, provincial and local government sectors at a national level of aggregation . Clayton (1966) followed the reasonable assumptions approach to derive fiscal incidence of the local public sector at the national level. Toronto Social Planning Council (1979) used the consumer survey approach to derive estimates for property tax incidence and the reasonable assumptions approach to impute benefits of public expenditures in Metropolitan Toronto. The Council, however, recognized the uncertainty associated with the allocation of public expenditure benefits and thereby relegated the incidence estimates to an appendix rather than presenting and discussing these in the main body of the report. Ballentine, Thirsk and Dean (1978) determine the benefit incidence of public transit and municipal welfare payments combining the two approaches cited above. Frankena (1973) has analyzed the distributional consequences of urban transit based on transit use data.

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[9] See also Barlow (1970), Borcherding and Deacon (1972) and Bergstrom and Goodman (1973).
[10] For an overview of criteria and procedures used for benefit imputation see Pfaff and Asam (1978).
[11] For a radical critique of these approaches see Gordon (1972), Grubb (1971), Michelson (1970) and Sawyers (1975).

Table 5.1 DISTRIBUTIONAL IMPLICATIONS OF APPROACHES TO BENEFITS INCIDENCE

BASIC ASSUMPTIONS		DISTRIBUTIONAL RESULT
Gillespie	Aaron and McGuire	
Allocation of Benefits by:		
Families	$\phi < 1$	PRO-POOR
Disposable Income	$\phi = 1$	NEUTRAL
Wealth	$\phi > 1$	PRO-RICH

Symbol ϕ = elasticity of the marginal utility of income.

Source: Ballentine et al. (1978), p. 147.

5.1.1 An Alternate Approach To Derive The Net Fiscal Incidence Of The Local Public Sector

A simpler and more straightforward approach to local budget incidence is possible with the help of disaggregated data on real estate transactions. We noted in chapters 3 and 4 that current tax payments and expenditures do not provide an adequate guide to the burdens and benefits of the local public sector. Residential property taxes lower residential property values and public expenditures enhance residential property values. The net effect of these two opposing influences would constitute net fiscal incidence of the local public sector. An approximation of this impact can be achieved by analyzing the change in residential property values due to the provision and financing of local public goods in the City of Edmonton as revealed by the house price regressions presented in chapters 3 and 4. The net effect could then be analyzed for distributional implications. [12] This approach is implemented in the remainder of this chapter and, where appropriate, incidence results are compared with other Canadian studies. [13] The mechanics of this approach is described in the following paragraphs.

To derive the incidence of the residential property tax , the empirical procedure involves the following steps:

Step I: The mean capitalized tax burden for each neighbourhood is obtained by multiplying the regression coefficient of the tax variable with the mean value of that variable for each neighbourhood.[14] We obtain 27 observations this way. This assumes that the marginal tax effects across neighbourhoods are the same whereas average effects vary due to differential effective tax rates and mean tax payment per household for various subareas within the City of Edmonton. These values are then annualized by applying a factor obtained from standard mathematical tables based on assumed values of the discount rate and the time horizon.

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[12] For a discussion on the concepts of redistribution see Hochman and Peterson (1974) and Reynolds and Smolensky (1977).
[13] For an analysis of fiscal incidence in the context of metropolitan area consolidation , see Bradford and Oates (1974), Cook (1973), Kiesling (1976) and Young (1976). For a study of fiscally induced migration in London (England) see Davies (1982).
[14] Danziger (1976) evaluates regression results at mean values in a study of the determinants of the level and distribution of family income. Goodman (1982) follows the same procedure to work out a geographic distribution of capitalized burdens of property taxes.

Step II: The resulting tax burden estimates are then classified by family income class (Table 5.2) using median family income of each neighbourhood (Table 5.7) as a criterion. These figures are then averaged for each class.

Exactly the same procedure is used for benefit estimation except that the mean neighbourhood tax variable values in step I are replaced by the neighbourhood public services indices (PSI). As the public services included in the index account for only 59% of total local public expenditure, benefit estimates are inflated by a factor of 1.7 (=1/0.59) to account for excluded services. [15] This assumes that benefits from omitted services are capitalized in the same manner as benefits from included services.

This approach is implemented in the remainder of this chapter and, where appropriate, incidence results are compared with the other Canadian studies. The focus of this approach is on total benefits and burdens as these are more easily perceived and enable us to compare our results with traditional studies on the subject. However, calculations based on a marginal analysis are also presented and substantiate the conclusions reached using the basic approach. Major limitations of this approach are discussed in section 4.7. It should be noted that our empirical analysis ignores renters and derives conclusions based on homeowners only. No claim can ,therefore, be made for the universality of these results. Furthermore, only aggregate income data is available to us for each subarea. Our analysis could be further refined if micro-data on family income distribution becomes available at a future date. Special notice must also be taken of the fact that the residential property taxes financed only 27.8% of expenditure for sample communities in 1977 and 12.4% of local government expenditure in Alberta in 1978. Thus if both the residential taxes and the local expenditures were completely capitalized, capitalized tax burdens would not offset capitalized benefits and a substantial fiscal surplus would result. Our empirical results, however, indicate nearly complete capitalization of taxes and only a very small portion of expenditure capitalization. Thus fiscal surplus, if any, would be small.

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[15] 59% figure is based on Chaudry (1980a).

An illustrative example of this approach is given in Appendix J.

5.2 THE DISTRIBUTION OF THE REVEALED BURDENS OF THE URBAN RESIDENTIAL PROPERTY TAX

Following the approach outlined in section 5.1.1, regression equations 3.103 and 4.52 are evaluated at mean values for each of the twenty–seven communities within the City of Edmonton. The capitalized tax burden estimates based on the coefficients of these regressions are then classified by family income class using median family income of each neighbourhood as a criterion. Table 5.2 describes the family income group classification used for this purpose. It also provides information on the distribution of households by income class in Edmonton. The resulting distribution of tax burdens is annualized using a discount rate of 2% and a time horizon of forty years and is presented in Table 5.3 and is also graphed in Figure 5.2.[16]

From Table 5.3 the absolute annualized tax burden per household increases with income for households having family income less than or equal to $20,000 and decreases with income for the remaining groups under Oates II (Equation 3.103). Using King–Reinhard II (Equation 4.52) the absolute burden can be approximated by an inverted U–shaped function of family income.

The progressivity of a tax is generally defined in terms of average rate of tax along income scale. [17] A tax is said to be

a. progressive when the average rate of tax rises with income;

b. proportional when the average rate remains constant and

c. regressive when it falls with rising income.

The concept of tax progressivity used here was initially proposed by Slitor (1948). Slitor stated that a tax system would be progressive , proportional or regressive if the first derivative of the effective tax rate with respect to income was greater than , equal to or less than zero respectively. This concept of progressivity implies that a tax system is progressive, proportional or regressive if the marginal tax rate is greater, equal to or

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[16] Appendix K provides similar calculations for a dozen selected regressions from chapters 3 and 4.

[17] See Kakwani (1980),p.245. See also Pigou (1947), Slitor (1948), Musgrave and Thin (1948), Dalton (1955) and Pfaff and Asam (1978).

Table 5.2 FAMILY INCOME DISTRIBUTION IN EDMONTON – 1977

Classification	Family Income ($) Range	Family Income ($) Median[a]	Percentage of Households
1	Under 15,999	14,934	30.2
2	16,000 - 17,999	17,200	6.2
3	18,000 - 19,999	19,356	7.3
4	20,000 - 21,999	20,954	7.6
5	22,000 - 23,999	23,766	14.0
6	24,000 - 25,999	25,196	
7	26,000 - 27,999	27,466	34.7
8	28,000 and over	39,416	
All Groups		21,663	100.0

a - based on sample values

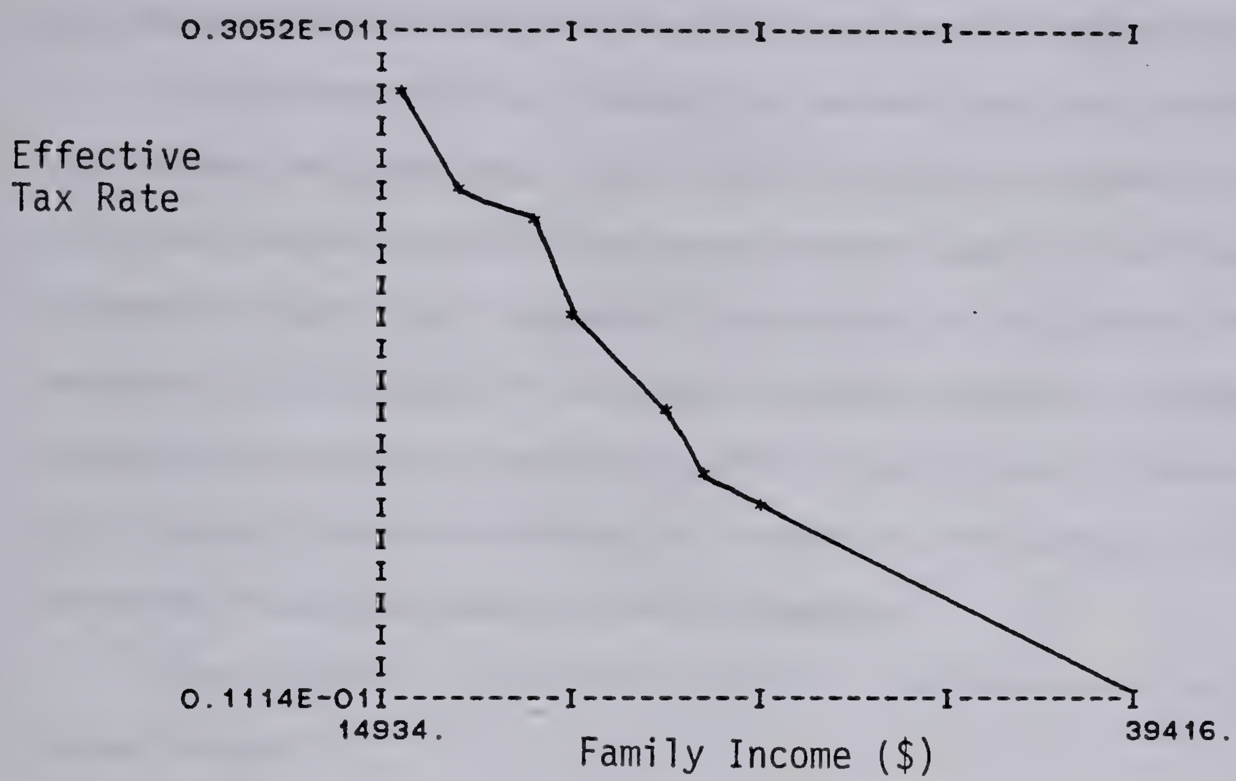
Source: Statistics Canada (1979a)

Table 5.3 REVEALED TAX BURDENS AND EFFECTIVE TAX RATES BY FAMILY INCOME CLASS

Family Income ($)	Annualized residential property tax burden per household($)*		Residential property tax burden as a proportion of of household income	
	Equation (3.103)	(4.52)	(3.103)	(4.52)
Under $15,999	455.77	384.28	.0305	.0257
$16,000 - $17,999	457.69	297.67	.0266	.0173
$18,000 - $19,999	492.30	342.52	.0254	.0177
$20,000 - $21,999	473.73	345.62	.0226	.0165
$22,000 - $23,999	477.10	494.09	.0201	.0208
$24,000 - $25,999	441.89	410.57	.0175	.0163
$25,000 - $27,999	451.63	458.52	.0164	.0167
$28,000 and other	438.91	426.04	.0111	.0108
Mean	461.13	394.91	.0213	.0177

* Assumes a discount rate of 2% and life of housing stock as 40 years.

Equation 3.103



Equation 4.52

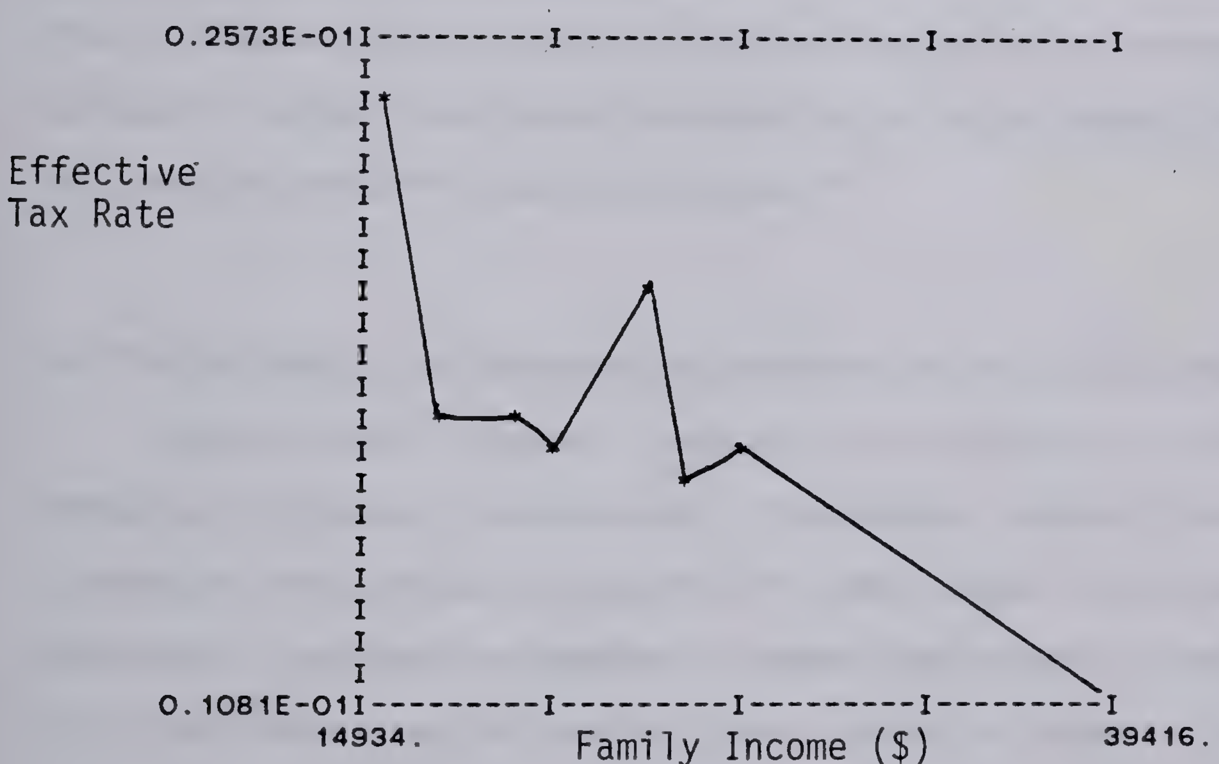


Figure 5.2 DISTRIBUTION OF TAX BURDENS BY FAMILY INCOME CLASS

(Effective Tax Rates)

less than the average tax rate respectively. Although other measures of tax progression are also available, this measure is most commonly used in fiscal incidence studies. [18]

The progressivity of revealed tax burdens using this measure is investigated quantitatively and graphically. Table 5.3 and Figure 5.2 show that the effective incidence of the tax burden falls with rising income lending support to the traditional view of the residential property tax. [19] Appendix K shows that the tax burden distribution shown by equation 3.1.03 is typical of the incidence pattern implied by the Oates model. Similarly equation 4.52 indicates a distribution pattern which is typical of the results based on the King-Reinhard approach although the incidence curve derived from this equation is somewhat flatter than those from other equations.

Two reasons are often cited for the regressivity of tax burdens on home-owners: [20]

1. assesors tend to underassess higher value homes; and
2. higher income families spend a smaller proportion of their income on housing relative to lower income families.

The first reason is borne out by the data for this study as the average effective tax rate is lower on higher priced homes compared to low priced homes. The second reason is supported by consumer expenditure surveys. [21]

5.3 THE DISTRIBUTION OF REVEALED BENEFITS OF THE LOCAL PUBLIC SECTOR

Slitor's (1948) concept of average rate progression is also applicable to an analysis of the degree of progressivity of expenditure benefits. Table 5.4 presents both in absolute terms and as a proportion of family income two series of estimates of distribution of expenditure benefits by income class based on regressions 3.103 and 4.52. The effective rate of benefits is also graphed in Figures 5.3. indicates a pro-rich distribution over the lowest end of the

The absolute levels of benefits indicates a pro-poor distribution for family incomes up to $20,000 and pro-rich beyond (see Table 5.4). The annualized benefits per

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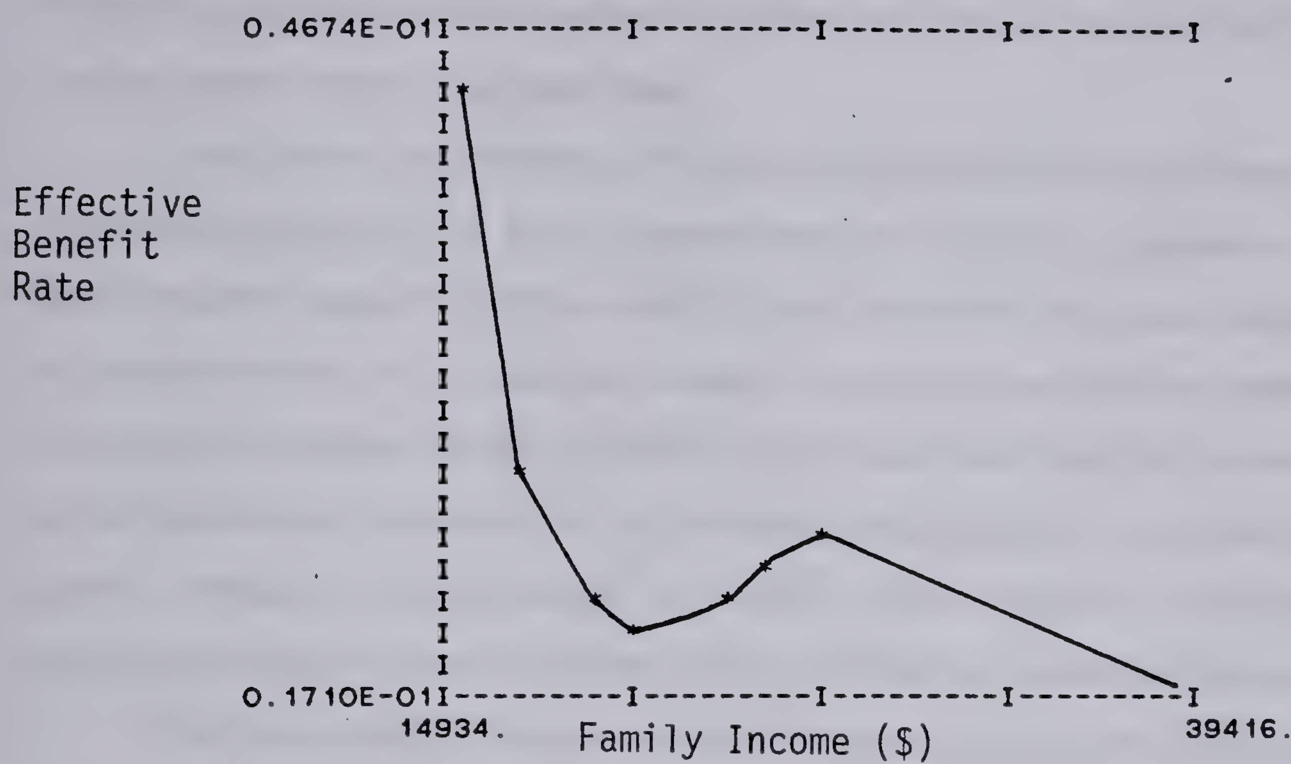
[18] See Suits (1977a,1977b,1980), Guthrie (1979), Kienzle (1980, 1981,1982) for recent contributions to the measurement of progressivity of the public budget.
[19] See Dahlby (1982), Bird (1976), pp.323-335 and Johnson (1976), pp.334-346.
[20] See Auld and Miller (1975),Netzer (1966) and Clayton (1966),p.76.
[21] See Reid (1962),p.1.

Table 5.4 REVEALED PUBLIC SECTOR BENEFITS AND EFFECTIVE BENEFIT RATES BY FAMILY INCOME CLASS

Family Income ($)	Annualized Local Public Sector Benefits ($)		Annual Local Public Sector Benefits As a Proportion of of Household Income	
	Equation (3.103)	(4.52)	(3.103)	(4.52)
Under $15,999	698.00	646.08	.0467	.0433
$16,000 - $17,999	462.62	428.21	.0269	.0249
$18,000 - $19,999	392.46	363.26	.0203	.0188
$20,000 - $21,999	422.33	390.92	.0201	.0187
$22,000 - $23,999	505.62	468.01	.0213	.0197
$24,000 - $25,999	556.32	514.9	.0221	.0204
$25,000 - $27,999	675.37	625.13	.0246	.0228
$28,000 and other	674.01	623.88	.0171	.0158
Mean	548.34	507.55	.0249	.0230

Equation 3.103



Equation 4.52

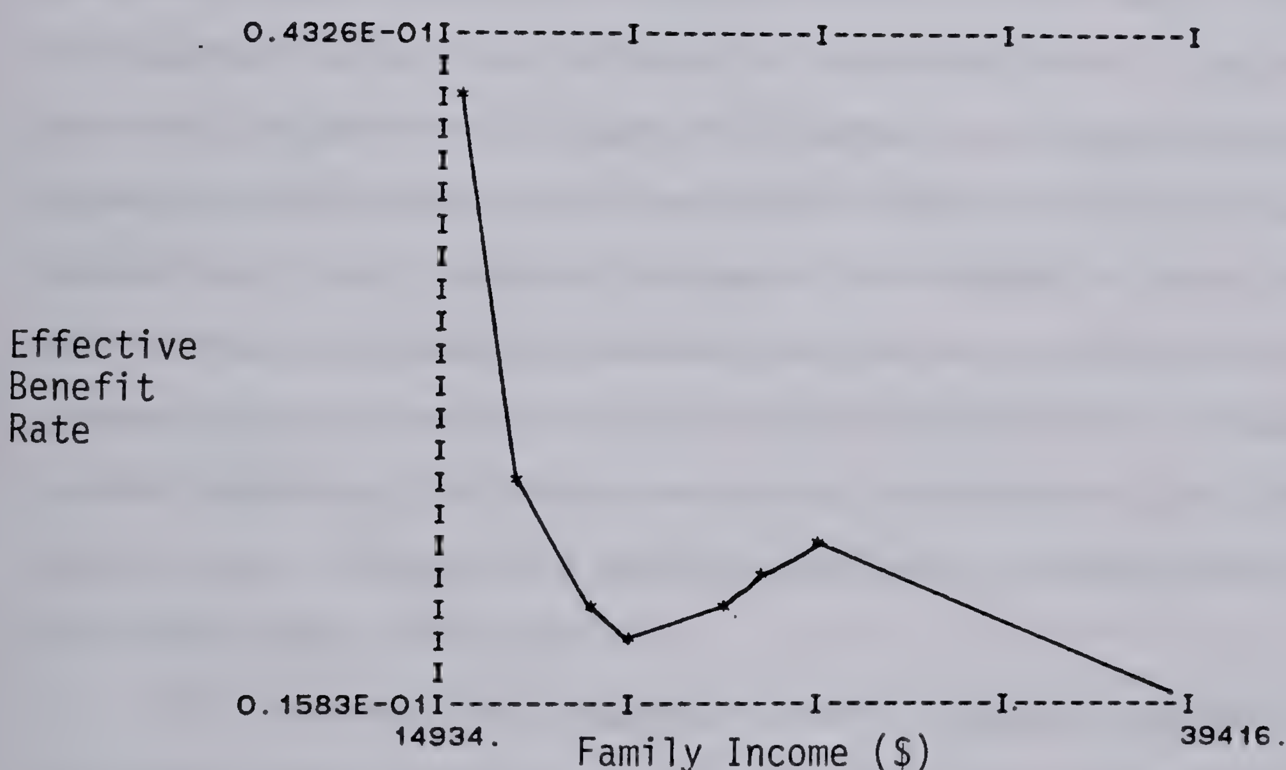


Figure 5.3 THE DISTRIBUTION OF LOCAL PUBLIC SECTOR BENEFITS BY FAMILY INCOME CLASS (Effective Benefit Rates)

household have the highest value for the lowest income group. This occurs because the downtown areas in Edmonton represent the largest single concentration of low income families but the same areas receive the highest ranking on the public services index (PSI) due to greater access to all amenities.

The graphic presentation of Figure 5.3 indicates that the incidence of benefits is regressive (pro–poor) for family incomes less than $22,000, progressive (pro–rich) over family income range $22,000 to $28,000 and regressive (pro–poor) beyond. This result is representative of all equations except those using expenditure measures of public services. We derived strictly regressive (pro–poor) distribution of expenditure benefits when results are evaluated for regressions incorporating an expenditure measure of public services (see Appendix K). These latter equations do not allow for intrajurisdictional variations in public services and are not helpful in our analysis.

The above results provide an interesting comparison with the conclusions of the traditional view of public expenditure benefit incidence espoused by Musgrave and Musgrave (1980) and Gillespie (1965) and a 'new view' presented by Gramlich and Rubinfeld (1982) . The traditional view states that the benefits of public services are *not* distributed in a pro–rich manner. Gillespie finds a neutral distribution whereas Musgrave and Musgrave find pro–poor distribution of educational benefits. It may be noted that the illustrative calculations of Gillespie and Musgrave and Musgrave are based solely on expenditures made and do not consider quality differentials within the community or the value at which public goods are assessed by the recipients of those services. [22] In the light of these conclusions high income individuals are more likely to emigrate from the community for fiscal reasons. [23] Gramlich and Rubinfeld (1982) on the other hand infer pro–rich distribution from the income elasticity of demand for public spending based on survey results. [24] Gramlich and Rubinfeld also do not consider public services quality differentials within a community.

The traditional view of expenditure benefit incidence is sustained in our estimates using dollar values of public expenditures. On the other hand when we consider quality

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[22] See Gramlich and Rubinfeld (1982),p.549.
[23] See Gramlich and Rubinfeld (1982),p.548.
[24] Katzman (1968), Berk and Hartman (1971), Owen (1972) and Mandell (1974) also reach the same qualitative conclusion for educational spending – a pro–rich distribution within cities.

differentials in public services provision within a jurisdiction , our results indicate pro-poor distribution (Musgrave and Musgrave result) over the poor and the lower middle class ranges , pro-rich (Gramlich and Rubinfeld findings) for upper middle class and pro-poor over the upper end of the family income scale. Thus our results suggest that whereas low income households are advantaged both absolutely and relatively, the high income individuals are advantaged absolutely but not relatively.

5.4 THE NET FISCAL INCIDENCE OF THE LOCAL PUBLIC SECTOR

In the previous sections we examined the incidence of the local public sector burdens and benefits . Here we combine the two influences to obtain the net fiscal residue (defined as benefits minus tax burdens) of the local public sector for eight income groups based on two alternate approaches. The absolute values of the net effect as well as the effective rate of fiscal incidence by income classes are presented in Table 5.5 . The net incidence is also graphed in Figure 5.4.

The annualized value of fiscal residuals per household in absolute dollar terms show a regressive (pro-poor) trend for family incomes up to $20,000 from equation 3.103 and up to $24,000 from equation 4.52 and progressive (pro-rich) beyond.

The net fiscal incidence according to the two series shares a pro-poor bias for family incomes less than $20,000, pro-rich distribution for income range $22,000 to $28,000 and pro-poor beyond. Mean net benefits are estimated to be less than one-half of one percent of household income.

We conclude that the overall fiscal incidence could be represented by an elongated U-shaped curve indicating a redistribution from the middle class to lower and upper income groups both absolutely and relatively. Our results contrast with Gillespie's findings based on an aggregative study (1976) that local fiscal residue is negative for lower income groups and positive for the remaining groups. The distribution of this residue, according to him, is pro-rich over the lower end and then proportional throughout along the family income scale. [25] Thus there is a redistribution of income from

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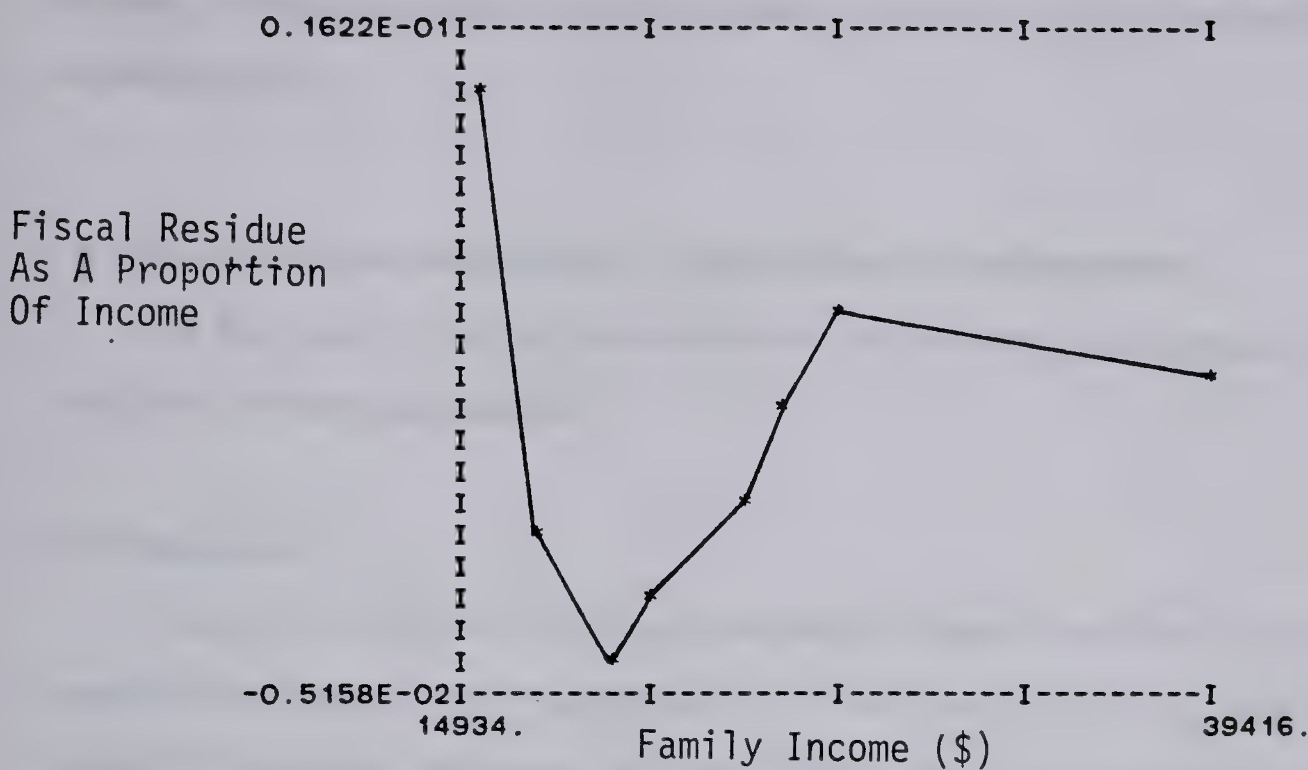
[25] Dodge (1975) results cannot be compared as he works out the combined effects of local and provincial governments nationwide. No clear pattern of fiscal incidence emerges from Clayton's (1966) work. Local fiscal incidence changes drastically from one allocative series to another.

Table 5.5 FISCAL RESIDUALS AND EFFECTIVE INCIDENCE RATE BY FAMILY INCOME CLASS

Family Income ($)	Net Local Public Sector Benefits (=Benefits-Tax Burdens) ($)		Net Benefits as a Proportion of Household Income	
	Equation (3.103)	(4.52)	(3.103)	(4.52)
Under $15,999	242.23	261.80	.0162	.0175
$16,000 - $17,999	4.9251	130.53	.0003	.0076
$18,000 - $19,999	-99.842	20.74	-.0052	.0011
$20,000 - $21,999	-51.402	45.30	-.0025	.0022
$22,000 - $23,999	28.525	26.08	.0012	-.0011
$24,000 - $25,999	114.43	104.36	.0045	.0041
$25,000 - $27,999	223.74	166.61	.0081	.0061
$28,000 and over	235.10	197.84	.0060	.0050
Mean	87.212	112.64	.0036	.0053

Equation 3.103



Equation 4.52

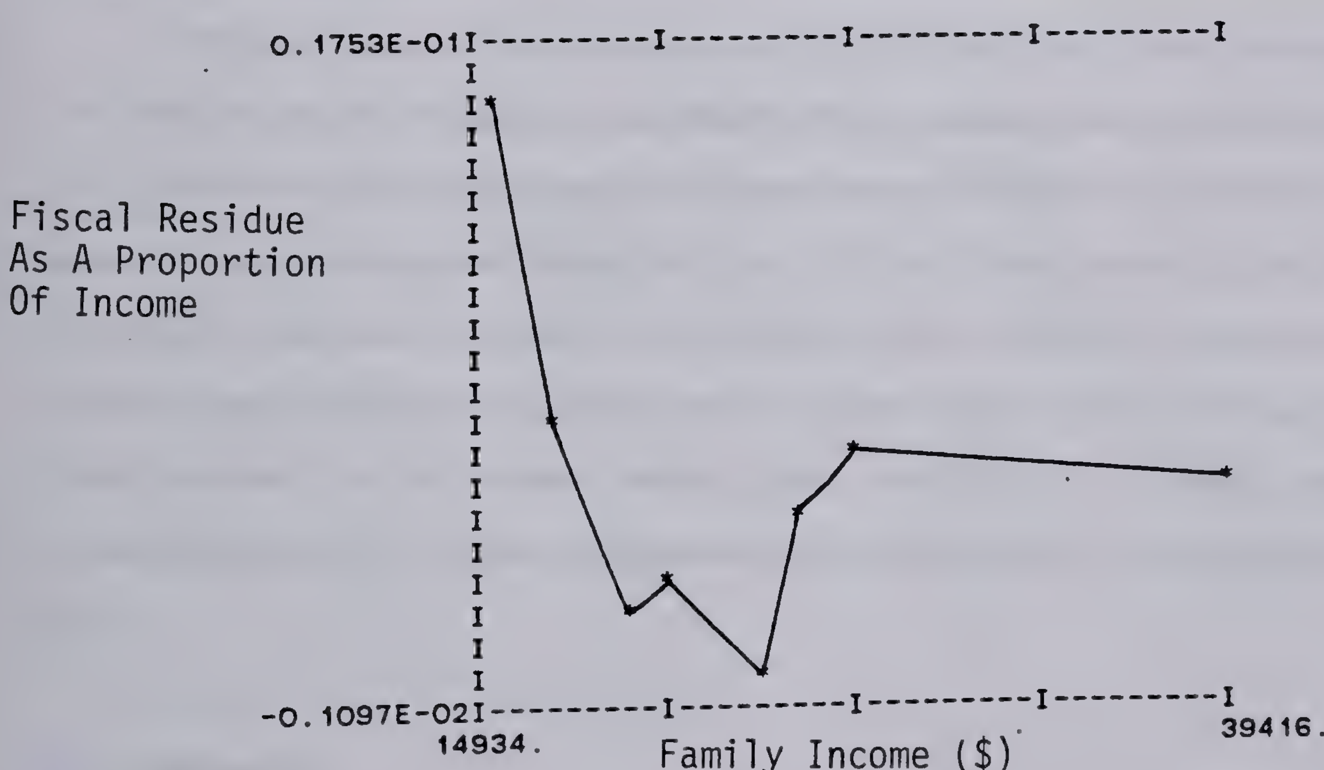


Figure 5.4 EFFECTIVE RATES OF NET FISCAL INCIDENCE BY FAMILY INCOME CLASS

the poor to the middle class and the rich. Gillespie's result derived from aggregate data, however, critically depends upon his concept of income and the assumptions underlying allocation basis.

5.5 THE NET FISCAL INCIDENCE : SOME FURTHER EXPERIMENTS

In this section the net fiscal incidence of the local public sector will be derived using two alternate approaches.

5.5.1 Method A

Here we compare the actual residential property tax bills with the annualized benefits determined from the capitalization of the benefits side only, assuming a discount rate of 2% and a time horizon of 40 years. Equation 4.52 (King–Reinhard II) is evaluated to derive annualized benefits of the local public sector .

Table 5.6 presents tax bills , annualized value of public service benefits and the net gain per household by family income class. The table also presents the effective rate of net fiscal incidence.

The table shows that average tax bill is $508 and class average annualized benefit per family is also $508 based on equation 4.52. In absolute terms benefits per household first decline with income and beyond income group $20,000–$21,999 show a consistent upward trend. Average net incidence is zero. The net fiscal incidence (see Figure 5.5) has a pro-poor bias over the family income range of up to $24,000 , pro-rich for incomes in the range $24,000 to $28,000 and pro-poor beyond. The effective rate is 1% of family income for the lowest income group and 0.2% for families having incomes exceeding $28,000. It is best represented by an elongated U-shaped curve (see Figure 5.5(i)).

5.5.2 Method B

So far our analysis has been carried out in terms of total burdens and benefits of the local public sector. Now we look at the distributional effects of a marginal change.

Let us assume that there is a 10% increase in property taxes per household. This is accompanied by an increase in the level of public services that such revenue would

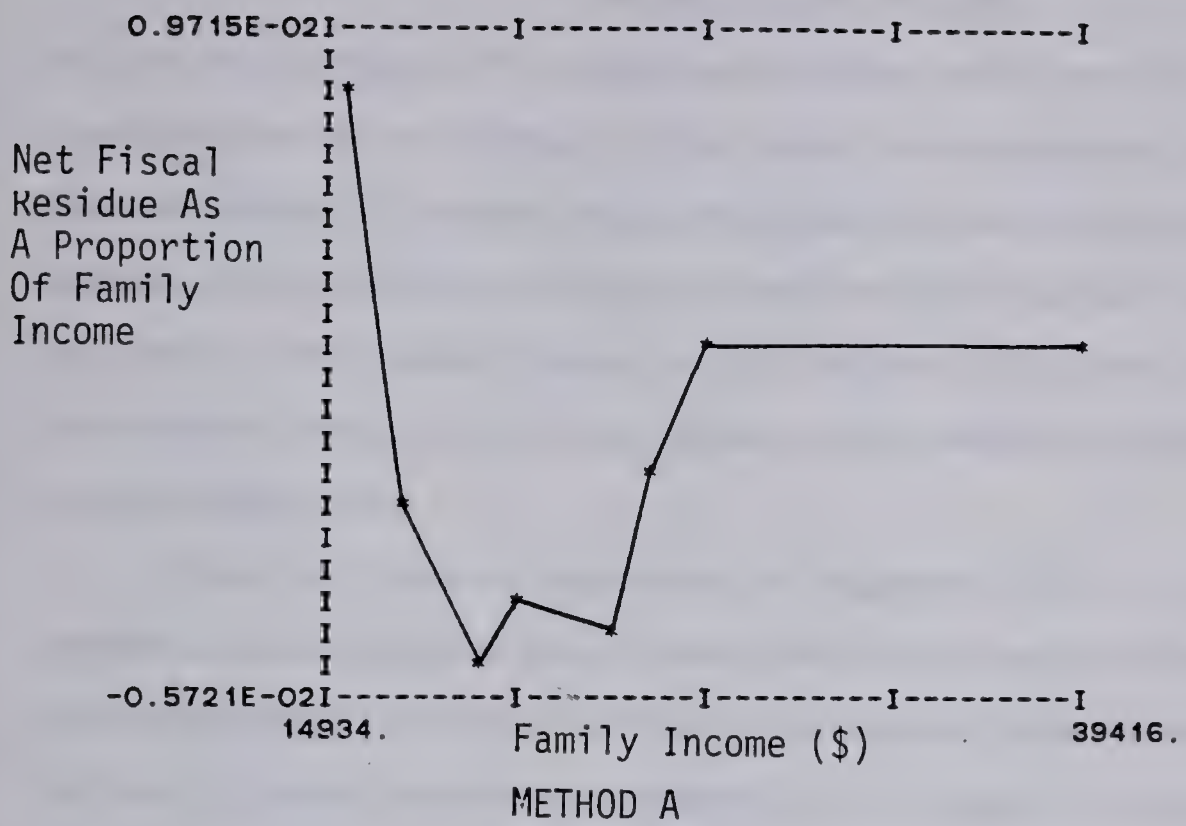
Table 5.6 THE NET FISCAL INCIDENCE : SOME FURTHER EXPERIMENTS

(i) Method A

Family Income ($)	Residential Property Tax Per Household ($)	Public Service Benefits ($)	Fiscal Residue ($)	Fiscal Residuals as a Proportion of Household Income
Under $15,999	501.0	646.08	145.08	+.0097
$16,000 - $17,999	445.0	428.21	-16.79	-.0010
$18,000 - $19,999	474.0	363.26	-110.74	-.0057
$20,000 - $21,999	476.0	390.92	-85.08	-.0041
$22,000 - $23,999	572.0	468.01	-103.99	-.0044
$24,000 - $25,999	518.0	514.94	-3.06	-.0001
$25,000 - $27,999	549.0	625.13	76.13	+.0028
$28,000 and over	528.0	623.88	95.87	+.0024
Mean	507.9	507.6	-0.3	-0.00004

(ii) Method B (Marginal Analysis)

Family Income ($)	Non-Annualized Change in Total Tax Burden ($)	Non-Annualized Change in Public Sector Benefits ($)	Non-Annualized Fiscal Residue ($)	Non-Annualized Fiscal Residuals as a Proportion of Household Income
Under $15,999	1938.6	3321.5	1382.9	+.0926
$16,000 - $17,999	1767.6	1601.3	-166.3	-.0097
$18,000 - $19,999	1882.8	1358.4	-524.4	-.0271
$20,000 - $21,999	1890.7	1461.8	-428.9	-.0204
$22,000 - $23,999	2272.1	1750.1	-522.0	-.0220
$24,000 - $25,999	2057.6	1925.3	-132.3	-.0052
$25,000 - $27,999	2181.7	2337.6	+155.9	+.0056
$28,000 and over	2097.3	2333.0	+235.7	+.0060
Mean	2011.1	2011.1	0.0	.000



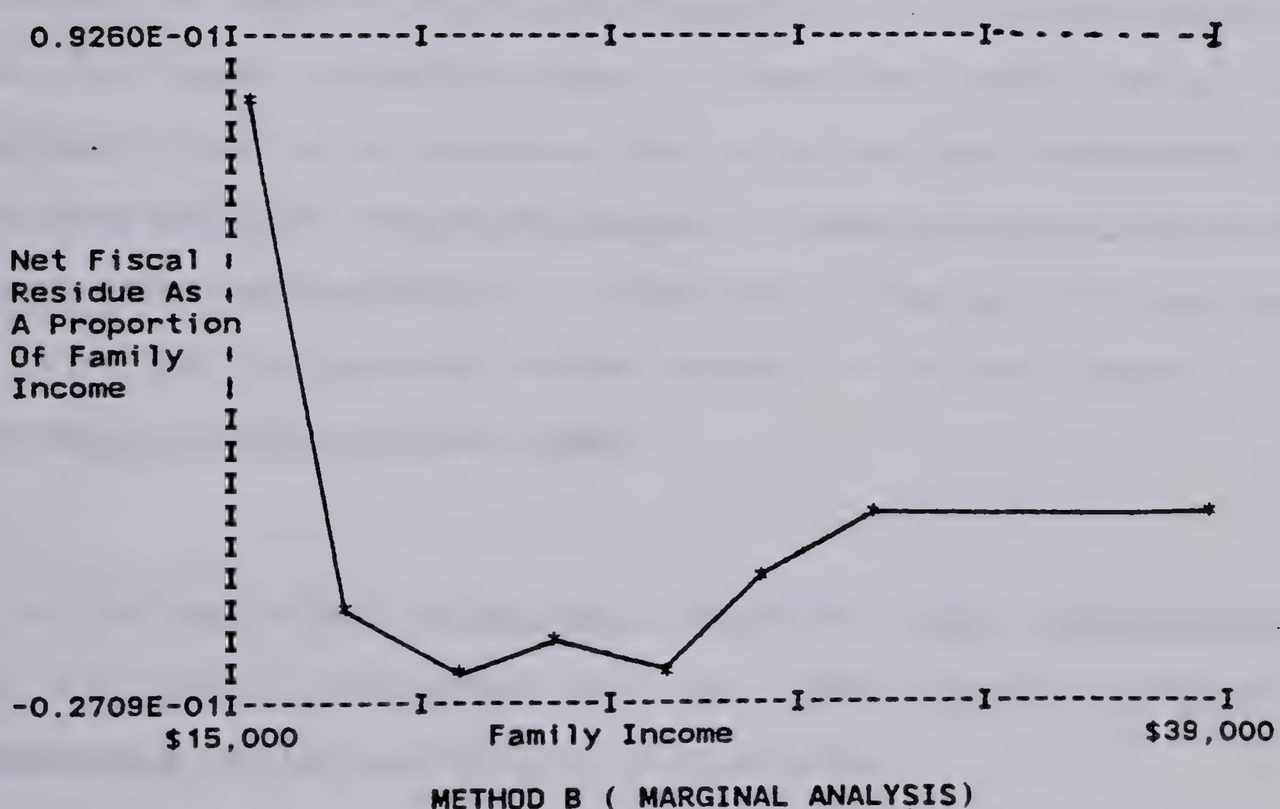


Figure 5.5 EFFECTIVE RATE OF NET FISCAL INCIDENCE USING ALTERNATE METHODS

finance. Based on equation 3.76 (see chapter 3) we further assume that :

$$dPSI/dLOCAL = .0011854$$

and that the increase in PSI would be distributed as PSI now. We further impose the constraint that the net change in dollar values of all properties as a whole due to the assumed change in property taxes and public services is zero. This implies that the marginal cost of additional tax dollar equals marginal benefits of additional local public expenditure. This scenario allows us to compare the pattern of net impact or the distributional effects of the local public sector without the difficulty of any overall surplus or deficiency.

Table 5.6 presents evaluations of equations 4.52 for the marginal change specified above. The values are not annualized. The distribution of tax burdens and public services benefits is consistent with estimates obtained under Method A . Once again the net fiscal incidence could be approximated by an elongated U-shaped curve (see Figure 5.5(ii)).

So far we have estimated the impact of the local public sector on family income distribution. We observed that the annualized effect of the change in property values is small with respect to family income for almost all income classes. Appendix L investigates if these small gains/losses due to the local public sector translate into any quantifiable impact on family income inequality as measured by the Gini coefficients. The appendix concludes that although the redistributional influences of the local public sector are minor, they do aggravate income inequality. In the next section we approach redistribution on an intercommunity basis.

5.6 THE DISTRIBUTION OF RESIDENTIAL PROPERTY TAXES, PUBLIC SERVICES AND THE NET FISCAL INCIDENCE OF THE LOCAL PUBLIC SECTOR AMONG NEIGHBOURHOODS WITHIN THE CITY OF EDMONTON

Here we examine interneighbourhood effects of the local public sector in the City of Edmonton based on an analysis of data on property taxes, public services, median family incomes and regression results from chapter 3. To study these effects, first the communities are ranked by property tax per household (TAX), the public services index (PSI) and median family income of the community (Y). A rank of one is assigned to an area

having the highest value of a particular variable. Table 5.7 displays these ranks. Spearman's (ρ) and Kendall's (τ) coefficients of rank correlation are then calculated to determine the magnitude and direction of association between any two variables at a time. Values of ρ and τ can vary from plus one to minus one. A value of plus one would indicate a perfect positive correlation between the ranks of two variables and a value of minus one indicates perfect negative correlation. The coefficients would be equal to zero if there was absolutely no association between the two measures. [26]

Table 5.7 shows that central city areas in real estate zones 13 (Downtown) , 26 (Clifton Place), 15 (Garneau), 11 (Windsor Park) and 10 (Crestwood and Valley View) receive higher rankings on both the TAX and PSI variables. Among the suburbs, Mill Woods (#29) and Castle Downs (#27) are ranked 10th and 11th respectively by the public services index.

The ranking of the communities by the two variables is consistent as is shown by Kendall's (τ)and Spearman's (ρ) rank correlation coefficients (see Table 5.8). Table 5.8 further shows that there is a weak positive relationship between median family income and the public services index. An inverse ranking of communities by the effective tax rate (T) and the house sales price (P) indicates that higher priced residences are underassessed.

A small degree of inequality in the geographical distribution of the local public services is revealed by the Gini coefficient of 0.33 (Pareto's α is 2.0051 and the standard error of α is .10288). [27]

With this brief analysis of the basic data we can now proceed to determine the net surplus (or deficiency) for a representative household (homeowner only) in different areas of the city. Our analysis ignores renters and hence our results would be less

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[26] See S. Siegel(1956).

[27] α is based on the following function proposed by Cowell (1977).

$$P_i = A\, x_a^{-\alpha}$$

where
P_i =log (1− (n−1)/n)
n = Number of observations.
A = A constant.
x_a = Array of public services indices in ascending order
α = Pareto distribution parameter.

Gini Concentration ratio is defined as:

$$G = 1/(2^{\alpha} - 1)$$

See Cowell (1977),p.153

Table 5.7 RANKING OF EDMONTON COMMUNITIES BY THE LEVEL OF PROPERTY TAXES, PUBLIC SERVICES AND MEDIAN FAMILY INCOME

	Community	Property Tax/ Household (TAX)		Public Services Index (PSI)		Median Family Income (Y)	
		$	Rank	Index	Rank	$	Rank
1.	Calder	453	20	.69226	22	19,400	18
2.	Balwin	467	16	.56804	26	19,596	17
3.	Northwest	544	6	.52752	27	20,630	11
4.	Sherbrooke	460	18	.92452	16	20,458	12
5.	Parkdale	496	12	.93197	15	15,548	25
6.	Newton	398	25	.86699	20	14,912	26
7.	North Glenora	417	24	1.14730	9	20,348	14
8.	Queen Mary	387	26	.89240	18	17,346	23
9.	Bellevue	345	27	1.05640	12	20,410	13
10.	Crestwood	529	8	1.57190	4	41,342	1
11.	Windsor Park	527	9	1.40700	5	37,490	2
12.	Oliver	577	4	1.30260	6	21,056	10
13.	Downtown	634	2	3.78230	1	13,508	27
14.	Lendrum	518	10	1.22900	8	25,196	5
15.	Garneau	675	1	1.60040	3	23,808	6
16.	McKernan	451	21	.86643	21	19,662	15
17.	Avonmore	435	23	1.00920	14	19,338	19
18.	Bonnie Doon	450	22	.87757	19	21,880	9
19.	Capilano	470	15	.63436	25	23,724	7
20.	Callingwood	459	19	1.27350	7	16,326	24
21.	Jasper Place	490	13	.90049	17	17,926	22
22.	Meadowlark	503	11	1.02290	13	27,336	4
23.	Beverley Heights	476	14	.67169	26	19,624	16
26.	Clifton Place	595	3	1.96170	2	27,598	3
27.	Castle Downs	462	17	1.11150	11	19,078	20
28.	Londonderry	543	7	.69122	23	21,890	8
29.	Mill Woods	576	6	1.14700	10	18,776	21

Table 5.8 RANK CORRELATIONS AMONG PAIRS OF SELECTED VARIABLES

(1977 Data for 27 Communities in Edmonton)

VARIABLE PAIR	Rank Correlation Coefficients: Kendall's Tau (τ) Coefficient	Kendall's Tau (τ) Significance level	Spearman's Rho (ρ) Coefficient	Spearman's Rho (ρ) Significance Level
TAX WITH PSI	0.2936	0.016	0.4158	0.016
P WITH PSI	0.3732	0.003	0.5317	0.002
T WITH PSI	-0.2593	0.029	-0.4689	0.007
Y WITH PSI	0.1168	0.196	0.1893	0.172
T WITH P	-0.1225	0.185	-0.3608	0.032

precise for the city areas with greater concentration of rental properties.

5.6.1 Fiscal Residuals By Neighbourhood

To determine the net impact of the local public sector for each community we determine the mean annualized value of public services benefits (assuming a discount rate of 2% and a time horizon of 40 years) for each community from the regression results of equation 3.103 and then subtract the residential property tax per household from benefit estimates. The net fiscal incidence derived in this way is reported in Table 5.9. The table shows that southwest areas of the city in general experience a net surplus and suburbs a net deficiency from the local public sector in Edmonton. Areas experiencing a surplus are shown as shaded areas on Map 5.1. The map shows that the local public sector appears to favour central and southwest city residents at the expense of dwellers in the northeast, northwest and southeastern areas of the city. The areas in the east and west side of the city have a relatively higher concentration of commercial and industrial properties vis-a-vis residential properties and so those areas likely have lower aggregate demand for local public goods measured by PSI e.g. education and recreation. This may explain the net deficiencies observed in those areas. The above results based on an analysis of fiscal residuals reinforce our overall conclusions regarding the net redistributive impact of the local public sector by family income class as the data reveals a greater concentration of middle income families in the suburbs.

5.7 VALIDITY AND LIMITATIONS OF THE APPROACH

Our redistributive estimates are based on capitalization . Thus our method is legitimate for small and open areas where communities have been sorted out by income class and taste. [28] The study area fulfills the small and open area condition but our community zones are not strictly consistent with income sorting. Thus homogenous

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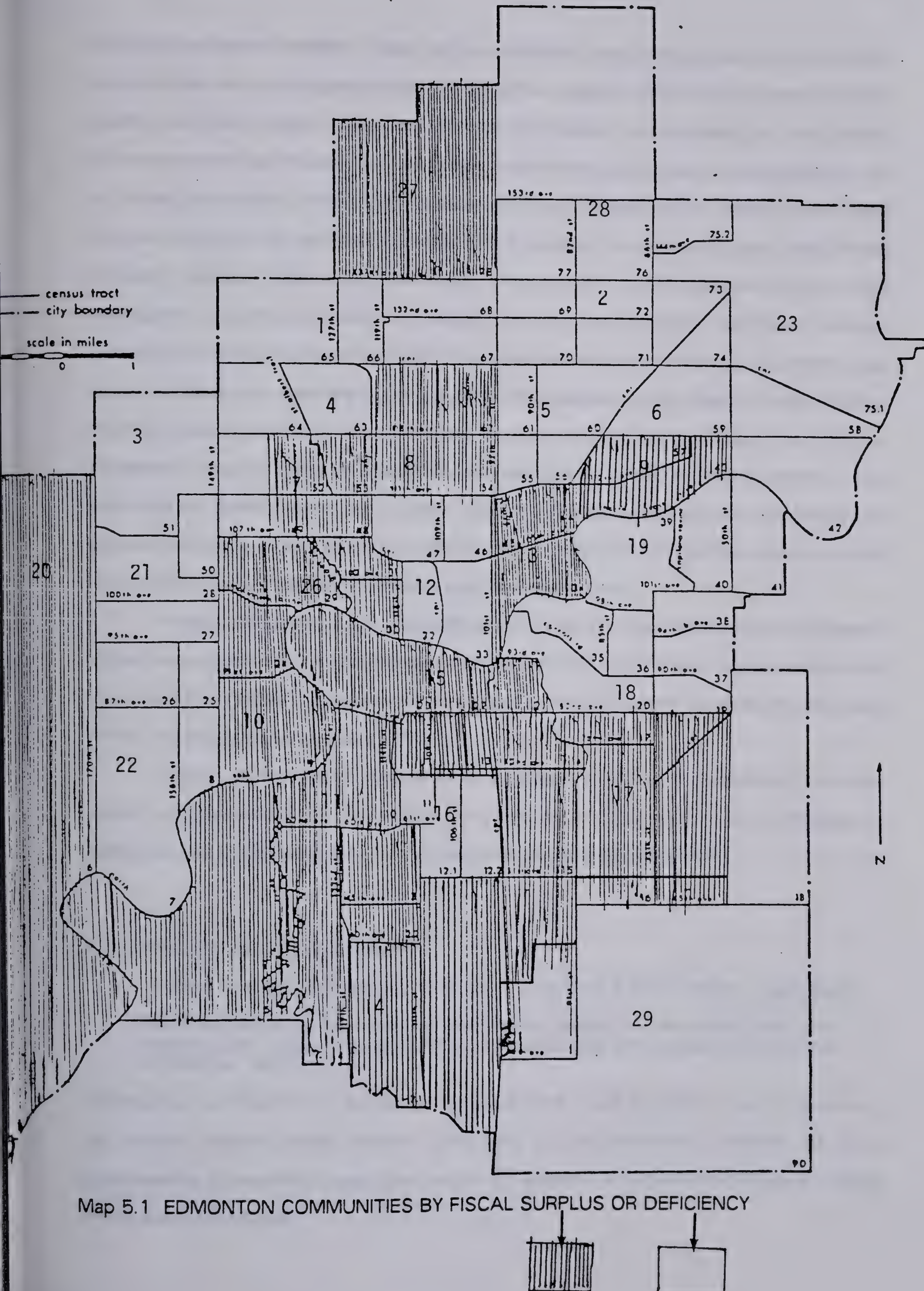
[28] These conditions have been specified by Polinsky and Shavell (1976) who demonstrate that a capitalization approach would be valid only "if the area affected is small (in which case the property value at location i depends only on amenities at i) and open (that is, there is full mobility). In that case competitive bidding by households for preferred locations will result in land values fully reflecting the value of differences in environmental quality (McMillan, Reid and Gillen"(1980),p.315).
Starret (1981) clarifies the capitalization mechanism in a system of local governments. His arguments are summarized in Chapter 1 of this study.

Table 5.9 FISCAL RESIDUALS BY COMMUNITY - CITY OF EDMONTON

	Community	Residential Property tax per household ($) (TAX)	Public Services Benefits fits per household ($) (PSB)	FISCAL RESIDUE = (PSB)-(TAX)
1.	Calder	453.00	304.89	-148.11
2.	Balwin	467.00	250.18	-216.82
3.	Northwest	544.00	232.33	-311.67
4.	Sherbrooke	460.00	407.18	-52.81
5.	Parkdale	496.00	410.46	-85.53
6.	Newton	398.00	381.84	-16.15
7.	North Glenora	417.00	505.30	88.30
8.	Queen Mary	387.00	393.04	6.03
9.	Bellevue	345.00	465.27	120.27
10.	Crestwood	529.00	692.31	163.31
11.	Windsor Park	527.00	619.68	92.67
12.	Oliver	577.00	573.70	-3.30
13.	Downtown	634.00	1665.80	1031.80
14.	Lendrum	518.00	541.28	23.28
15.	Garneau	675.00	704.86	29.85
16.	McKernan	451.00	381.60	-69.40
17.	Avonmore	435.00	444.48	9.47
18.	Bonnie Doon	450.00	386.50	-63.49
19.	Capilano	470.00	279.39	-190.61
20.	Callingwood	459.00	560.88	101.88
21.	Jasper Place	490.00	396.60	-93.40
22.	Meadowlark	503.00	450.51	-52.48
23.	Beverley Heights	476.00	295.83	-180.17
26.	Clifton Place	595.00	863.98	268.98
27.	Castle Downs	462.00	489.53	27.53
28.	Londonderry	543.00	304.82	-238.18
29.	Mill Woods	576.00	505.17	-70.83
Mean		493.96	500.28	6.31
Standard Deviation		75.15	276.16	242.86
Minimum		345.00	232.33	-311.67
Maximum		675.00	1665.80	1031.80



Map 5.1 EDMONTON COMMUNITIES BY FISCAL SURPLUS OR DEFICIENCY

incomes and taste condition would not be satisfied. Also preferences for local public services may vary significantly within the specified subareas in the City of Edmonton. The public services indices used for various Edmonton communities do not reflect intra-community variations in service levels. Thus the fiscal residuals may be different for different households within the subareas studied. Another major limitation of these indices is that they do not capture variations of all locally provided services. Even for the included services, there may be large measurement errors. Income data is also aggregated to community level and subject to error. Also, within community income distribution data is simply not available. Any imperfections in the local housing market also work to make our estimates less precise. For example, a shortage of high income oriented housing compared to say middle income housing would force a high income household to buy housing services at the market price in middle income jurisdiction. This individual will thus experience a negative fiscal residual as he may not usually be willing to pay as much as a middle income household for a high level of middle income oriented local public services say public schools and public transit etc.

A major limitation of our approach arises from the fact that changes in property values may reflect the tax burdens and service benefits but if these were expected and capitalized into property values when the property was purchased it would not adversely affect or benefit existing owners. [29]

In spite of the above limitations the approach adopted in this chapter provides useful insights relating the distributional implications of local public goods provision in Edmonton and merits consideration for empirical application elsewhere.

5.8 SUMMARY AND CONCLUSIONS

Almost two decades ago Aaron Director proposed a law of public expenditure:

> "Public expenditures are made for the primary benefit of the middle class, and financed with taxes which are borne in considerable part by the poor and the rich"(Stigler 1970, p.1).

An empirical verification of this law at the local level could be carried out by examining the income redistributional effects generated by the economic activities of local governments. Economists have just begun to address this question. Gillespie (1976)

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[29] See Hamilton (1976a).

employs the 'reasonable assumptions' approach and concludes that the local government sector at the national level of aggregation appears to redistribute income from the poor to the rich and middle class. If the pro-rich local public services benefits distribution inferred by Gramlich and Rubinfeld (1982) is combined with a regressive incidence of the real property tax, the net redistributive impact of the local public sector would be to favour the rich at the expense of the poor and the middle class residents. The present study avoids difficulties associated with the reasonable assumptions approach and approximates the net fiscal incidence from changes in residential property values. Thus the estimated redistributive effects are not illustrative but real and cast a considerable shadow of doubt on the pattern of income redistribution derived from earlier studies. Our empirical results refute Director's law and imply that the local public sector redistributes income from the middle income families to the poor and the rich.

The following overall conclusions emerge from the analysis of this chapter.

1. The incidence of the residential property tax is highly regressive (pro-rich). The absolute burden, on the other hand, initially increases with income and then decreases with income. It can be approximated by an inverted U-shaped function of family income.
2. The incidence of expenditure benefits is regressive (pro-poor) for those earning less than $22,000 and progressive (pro-rich) for family incomes in the range $22,000 to $28,000 but regressive (pro-poor) for the richest class (family incomes $28,000+). [30]
3. The overall impact of the local public sector in Edmonton is to redistribute income from the middle class to the poor and the rich.
4. The local public sector aggravates income inequality in Edmonton. The overall impact on the distribution of income, however, is very small.[31]

The above results also help explain the rapid growth of two middle class suburbs namely the City of St. Albert and the Hamlet of Sherwood Park just at the boundary of the City of Edmonton. Middle income residents from Edmonton have migrated to these

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[30] These estimates are consistent with Weicher's (1971) estimates for police expenditures using Chicago (1959) data.
[31] This effect is statistically insignificant. See Appendix L.

communities in view of the fiscal deficiency perceived by these groups in Edmonton. [32] Since these communities have very few poor families and high concentration of middle income groups there would be very little if any income redistribution or cross-subsidization. This helps explain the strong opposition voiced by these communities to Edmonton's annexation bid in 1980. Thus a very small dollar amount of redistribution affected by the local public sector is perceived to be marginally very important indeed by local residents. [33]

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[32] Muth (1969) has found that the growth of low income population in a central city tends to increase the size of suburban population. He attributes this result to aversion of rich families to rising health and welfare expenditures. The present study suggests that the same result may occur due to all local expenditures. See also Weicher (1971),p.219.
[33] Public opinion polls conducted in the region from time to time have never addressed this question. See, for example, Burton (1979).

6. SUMMARY AND CONCLUSIONS

A major objective of this study was to carry out an empirical test of the capitalization hypothesis using data from a Canadian urban area. This hypothesis states that if consumers shop among local communities, fiscal differentials among communities will be capitalized into residential property values. This simple idea is potentially very powerful for it not only provides a simple measure of individual preferences for local public goods but it also has important implications for the equity and efficiency of local public goods provision.

The efficiency implications of this hypothesis have led to much controversy and debate in recent years. Due to the complexity of this issue, the issues are not yet resolved. In Chapter 1, we summarized the opposing and conflicting viewpoints on the subject and presented a synthesis of the Tiebout literature. In doing so, we clarified the concepts of tax and benefit capitalization. Empirical tests of the Tiebout hypothesis were outlined and the theoretical underpinnings of the capitalization literature were elucidated. We discovered that contrary to Oates' earlier claims that the capitalization hypothesis provides an empirical test of the Tiebout hypothesis , it is merely a test of the empirical relevance of Tiebout's postulate on consumer mobility or what Oates now calls a test of the demand side of the Tiebout model. The existence of capitalization when jurisdictional boundaries are fixed exogenously merely indicates that consumers *shop* among local communities. It is, therefore, not a test of the Tiebout hypothesis which is a normative statement as to the efficient functioning of the local public sector. The capitalization of fiscal variables only implies that consumers shop among competing local jurisdictions but does not offer unambigous inferences as regards the implications of this for efficient provision of local public goods.

We examined migration models as an alternate approach to test the Tiebout hypothesis and noted that these models merely test if would be migrants consider fiscal variables in their location choice but offer no insights as to the implications of this behaviour for efficient functioning of a system of local governments.

The study is based upon data from the City of Edmonton, Alberta , Canada and eight major neighbouring urban centres which have primarily grown as bedroom communities for Edmonton. The study utilized house sales data obtained from the

Edmonton Real Estate Board. The data on public services was supplemented from other sources.

The assessment and taxation data collected for this study was analyzed for intrajurisdictional variations in effective tax rates and assessment-sales ratios and sample communities were ranked according to their assessment performance. Edmonton and St. Albert ranked poorly compared to other sample communities. The analysis shows that roughly one-third of properties in St. Albert were either over or under-assessed by more than 60% . Considering that the mean price of a St. Albert house in 1977 was $57,349 , a 60% assessment error (assuming mean assessment sales-ratio of .104) would be a $3,579 error and a tax difference of $305 per annum. In the City of Edmonton roughly one-third of the properties were either over or underassessed by more than 21% in 1977. This performance does not compare well to that of Metro Toronto where in 1976 only 8.6% of properties were overassessed by more than 21%. The extent of intrajurisdictional variations in effective tax rates and sales-assessment ratios may be a matter of concern. Some conjectural comments on the causes of intrajurisdictional variations in assessment-sales ratios are offered in Chapter 2. It is argued that within the City of Edmonton, high assessment errors may in part be attributable to an inadequate consideration of the public sector characteristics in assessment technology by local assessors. It is suggested that an application of the methodology used in this study should significantly reduce this error.

Several aspects of the empirical approach to capitalization utilized in this study are highlighted in the following paragraphs. These elements , we think, should be included and improved upon in future studies of capitalization.

First, contrary to majority of studies on this subject, we utilized accurate large scale disaggregated data on real estate transactions . The study also developed output indicators of local public services for sample municipalities as well as for twenty-seven sub-areas within the City of Edmonton.

The second important aspect of our approach is the careful consideration of econometric estimation problems encountered in this study. Important econometric issues relating to functional form, estimation procedure, muticollinearity and simultaneity bias were addressed. The Box-Cox transformation of the data offered improvement

over adhoc specifications. In dealing with the multicollinearity problem in our data, canonical analysis was judged superior to variable selection, ridge regression and the principal component analysis. Canonical composite indices of public services , structure and site characteristics were formed to overcome the severe multicollinearity detected in the data set. The public services indices so composed later proved extremely useful in deriving improved estimates of capitalization of the local public sector and redistribution affected through the local public sector within the City of Edmonton. Our empirical results also demonstrated the superiority of these indices over expenditure measures of public services. The estimation procedures utilized in this study included Ordinary Least Squares, Two Stage Least Squares, Restricted Least Squares and Non-Linear methods.

The third important aspect of our study is the comprehensive treatment of capitalization of property taxes and public services. Tax capitalization is estimated both using effective tax rates (Oates approach) and tax bills (King-Reinhard approach) variables. Furthermore, both within and across jurisdictions tax capitalization estimates are presented. Public services capitalization is investigated using both the expenditure and output measures of public services.

Finally and most crucially the capitalization results are used to evaluate the efficiency and distributional implications of local public goods provision in Edmonton.

CONCLUSIONS

The following broad conclusions emerge from this analytical excursion.

Public Sector Capitalization

The empirical evidence is overwhelmingly in favour of complete capitalization of both intra and inter-jurisdictional variations in residential property taxes and only partial capitalization of local public services. Although the precise estimates vary according to the model selected, the econometric technique used and the assumptions regarding the discount rate and the time horizon , overall conclusions are consistent. Also broadly consistent conclusions are reached using alternate property tax capitalization approaches suggested by Oates, King and Reinhard. The former approach utilizes effective tax rate

variable whereas the latter is based on tax bill per household. Also regressions employing the composite indexes of public services obtain robust results on effective tax rate and tax level capitalization. The results imply that property tax differentials both due to assessment errors and interjurisdictional variations are perceived and reflected into housing prices.

The use of a quality index of public services leads to more precise capitalization estimates although the general conclusions derived from the use of expenditure measures of public services output are sustained. A very small degree of public expenditure capitalization is suggested by these estimates. This small degree of expenditure capitalization is consistent with Simon's hypothesis [1] that redistributing services would have less of a disruptive influence on property values than adjusting property taxes as taxes , he suggests , are capitalized fully but services are not capitalized to the same extent. This happens because public services variations are less easily perceived than property tax variations. This result also implies that the provision of local public services in Edmonton may not be consistent with efficiency.

Efficiency Implications

Implications of capitalization for efficient provision of local public goods were drawn based on a property value determination model suggested by Brueckner (1979,1982) and a balanced budget approach. The regression results based on the former approach suggest overprovision of public goods in sample communities of Edmonton, St. Albert and Sherwood Park but not in the other communities. The application of the balanced budget approach implied that the provision of local public goods in the Metropolitan Edmonton region was not consistent with efficiency . The results suggested that the marginal effect on house price of a dollar increase in per capita expenditure financed solely by residential property taxes would be negative.

Distributional Implications

We analyzed the distribution of capitalized benefits and burdens of the local

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[1]See Simon (1943a, 1943b) and Noto (1976b),p.31

public sector and found that the results do not support Director' law[2] and instead imply that the local public sector redistributes income from the middle income families to the poor and the rich. The following overall conclusions emerge from this analysis.

1. The incidence of the residential property tax is highly regressive (pro–rich) i.e. the average rate of tax along income scale falls with rising income.
2. The incidence of expenditure benefits is regressive (pro–poor) for those earning less than $22,000 in 1977 and progressive (pro–rich) for family incomes between $22,000 to $28,000 but regressive (pro–poor) for the rich (family incomes $28,000+).
3. The overall impact of the local public sector in Edmonton is to redistribute income from the middle class to the poor and the rich.
4. The local public sector aggravates income inequality in Edmonton. The overall impact on the distribution of income , however, is very small and statistically insignificant.

The above results also help explain the rapid growth of two middle class suburbs namely the City of St. Albert and the Hamlet of Sherwood Park just at the boundary of the City of Edmonton. Middle income residents from Edmonton have migrated to these communities in view of the fiscal deficiency perceived by these groups in Edmonton . Since these communities have very few poor families and a high concentration of middle income class groups, there would be very little if any income redistribution or cross–subsidization. This helps explain the strong opposition voiced by these communities to Edmonton's annexation bid in 1980. Thus a very small dollar amount of redistribution affected by the local public sector is perceived to be marginally very important by local residents.

The Tiebout Hypothesis

Our empirical results confirm the operation of the demand side of the Tiebout model in Metropolitan Edmonton but the functioning of this mechanism does not lead to efficient or equitable provision of local public services in the region.

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[2] Director' law : "Public expenditures are made for the primary benefit of the middle class, and financed with taxes which are borne in considerable part by the poor and the rich" (Stigler 1970,p.1).

Suggestions For Future Research

This study is a comprehensive empirical investigation into the capitalization of local property taxes and public services. Yet it marks only a first step in an effort to develop a fuller understanding of the fiscal incidence of the local public sector in Canada. Future research could build upon our present framework by extending the analysis to the impact of public sector on renters as opposed to homeowners. One could also use this framework for an indepth analysis of a specific local public service. The effects of intergovernmental assistance, land use controls and other policy variables could also be incorporated into a more complex model. One could also examine business location behaviour in a fiscally differentiated environment. Finally empirical application of a carefully specified general equilibrium model of local communities in a metropolitan area could be investigated.

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Appendix A

SUMMARY OF PROPERTY TAXATION AND ASSESSMENT PROCEDURES IN ALBERTA[1]

The real property tax is the single most important source of revenue for Alberta municipalities. Hence the assessment base from which the property tax revenues are generated serves as an important index of fiscal capacity of municipalities. It is, therefore, useful to briefly summarize property taxation and assessment procedures applied by urban municipalities in Alberta.

All taxable property is subject to municipal property taxation by the municipality in which it lies. In addition, taxable property may be subject to taxation for the purposes of requisitions imposed by other agencies particularly school boards. The amount of property tax levied against a particular property is a function of the mill rate and the assessed value of the property. The municipal mill rate is set annually by the local council to generate the tax revenue required to meet budgeted expenditures while the mill rate(s) for requisition purposes are set to generate the revenue required to pay for the requisition. The mill rate represents the taxes payable per $1000 of assessed value.

A number of types of property are exempt from property taxation including institutional property (schools, universities, colleges, hospitals, libraries, nursing homes), property of non-profit and charitable community organizations, churches, cemeteries, farm residents (up to $28,000 assessment since 1980) and buildings, municipal property, and property owned by the provincial or federal governments. In the case of crown property, however, the federal and provincial governments pay an amount equivalent to actual property taxes on some of their property by way of grants-in-lieu of taxation. The Province pays on most of its properties but not on hospitals or educational institutions. The federal government pays on their properties as specified in the Federal Municipal Grants Act.

With the exception of railway mainlines which are assessed by statute at $1000 per mile, the assessment value for various properties is defined by provincial regulations. An assessment manual is used to provide uniform data and methods for assessment throughout the Province. 1977 assessment values were computed using the 1967

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[1] Much of this is extracted from Alberta Provincial Municipal Finance Council (1979).

assessment manual. Under the 1967 manual, non-agricultural land in an urban municipality is assessed at 65% of market value (determined from market sales data) in the year preceding the last general assessment, buildings and structures are assessed at 45% of depreciated 1963 replacement costs. Commencing December 31, 1977 both land and buildings came to be assessed at 65% of market value. A new Alberta assessment manual was regulated in December 1979. The values used in this new manual are based on 1977 replacement costs in Edmonton and area. For assessment purposes the costs found in this manual will be modified to reflect values in the year of the assessment. The 1979 assessment manual was used for the first time to calculate assessments for the 1981 taxation year.

In the City of Edmonton land assessment takes into consideration locational factors such as nearness to the river valley (up to 12% appreciation) and location on a cul de sac (3% appreciation). The basic factors used are the following and then depreciation and appreciation factors are added to obtain an index of land assessment for each community.

Unserviced land	60%
Sewer and water	18%
Walks, curbs and gutters	8%
Gravelled roads	4%
Paved roads	10%
Fully serviced lot	100%

Assessment of improvements in 1977 was based on 45% of depreciated 1963 replacement costs[2] The total assessed value of a dwelling is then depreciated using the following factors.

Bus Route	4%
Bus Stop	7%
Traffic	3 to 15%
Service Stations, Garages, Machine Shops	7 to 20%
Apartments	3 to 8%
Stores and Shopping Centres	6 to 5%
Schools	3 to 4%
Lanes (through traffic)	1 to 10%
Churches (Adjoining only)	3%

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[2]A specimen of residential property assessment card is included in the appendix.

Under The Municipal Taxation Act, a general assessment of all property within a municipality is to be undertaken at regular intervals, at which time land values are updated, accrued depreciation on replacements is calculated, and if the last general was based on an older assessment manual, replacement costs are calculated on the basis of the current manual. Values determined in a general assessment may be used by a municipality (by passage of an appropriate by-law) for up to seven consecutive years. After that time, the municipality is required to undertake a new general assessment unless the Minister of Municipal Affairs grants a special extension. In Edmonton two recent general assessments were undertaken in 1973 and 1979.

The Assessment Equalization Board of Alberta Municipal Affairs calculates equalized assessments (defined earlier) for all municipalities annually. The process of equalization involves two main calculations: first, the updating of actual assessments from the last general assessment to reflect reasonably current values and costs and second, by reducing the percentage of market value for urban land assessment so that the assessed value of urban and rural non-agricultural land are comparable. Since equalized assessments for all municipalities are adjusted to the same year, they are comparable between municipalities. Equalized assessments are used to determine school supplementary, school foundation program, senior citizens homes, recreational area and planning fund requisitions upon the municipal tax base, and as a measure of municipal need for the distribution of provincial grants.

Appendix B

DESCRIPTION OF MUNICIPAL SERVICES AND SOURCES OF REVENUE FOR ALBERTA MUNICIPALITIES [1]

Alberta municipalities are entrusted with a number of public service delivery responsibilities. The provision and financing of these services is described in the following main categories.

a. Municipal Operating Expenditures

b. Municipal Operating Revenues

c. Municipal Capital Services

d. Municipal Utility Services

A. Municipal Operating Expenditures

A brief description of various expenditures categories is reported below:

General Government

This category includes expenses for municipal administration, tax collection, audit costs and financial and other costs which cannot be allocated to other areas.

Police protection

Urban municipalities with a population of 1500 or greater are required to arrange for own police force or to sign a municipal policing contract with the RCMP.[2]. The police protection in rural areas and urban centres with a population of less than 1500 is provided by the RCMP and paid for by the Province.

A policing contract with the RCMP in 1977 entailed the payment by the municipality of 53% of the manpower costs for the first five police officers and 78% of the costs for additional men.

Fire Protection

The fire protection service is strictly local responsibility. Most urban municipalities in Alberta, with the exception of the larger cities, provide the service through a primarily volunteer fire department.

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[1]Much of this is extracted from Alberta Municipal Affairs (1978, 1981). See also Chaudry (1980a, 1980b).

[2]Of the 72 municipalities in Alberta responsible for policing, only eleven had their own police force in 1980.

Other Protection

This category includes the services of ambulance, buildings and safety inspectors, local by-law enforcement and emergency measures.

Transportation Services

This category includes expenditures on the maintenance of roadways, streets and related facilities such as bridges, tunnels, storm drainage systems, street lighting and traffic services. It also includes common costs of overall transportation system. Cities in Alberta are responsible for all roads within their jurisdiction; towns, villages and incorporated rural municipalities are responsible for all roads except the construction and maintenance of provincial primary highways and the construction of provincial secondary highways.

Public Transit

Expenditures for the provision of transit services are reported in this category.

Sewage Collection and Disposal

Municipalities are responsible for the construction, operation and maintenance of sanitary sewage systems. Such systems must meet provincially-regulated standards.

Waste Collection and Disposal

This service is also a municipal responsibility which must meet provincially-regulated standards.

Public Health and Welfare

The responsibilities of Alberta municipalities with regard to health and welfare services are limited to community-based social programs, most of which are categorized as Preventive Social Services. The provision of such services is optional.

Environmental Development

This function consists of programs which are undertaken to provide for the physical development of municipalities. Includes local planning and zoning, agriculture service boards, tourism, convention facilities etc.

Recreation and Culture

Municipalities provide parks and recreation facilities and services. They also are responsible for providing cultural services such as museums, auditoriums, zoos, art galleries and libraries.

Debt Charges and Fiscal Services

These are purely financial transactions and include debt charges and transfers to own sources, funds and agencies.

Requisitions

These include school, regional health and planning requisitions.

a. School Requisitions. Kindergarten to grade 12 schooling in Alberta is provided by local school boards or divisions. A school board or division has the authority to requisition municipalities within its jurisdiction for 'supplementary' costs (costs not covered by Provincial grants). The Province also requisitions all municipalities for a portion of the cost of the School Foundation Program. The requisition is annually calculated through the application of a provincially-set mill rate to municipality's 'equalized assessment for School Foundation Purposes'.

b. Regional Health and Planning Requisitions Local hospital boards may requisition municipalities for capital costs associated with the improvements, provision of staff housing beyond the level financed by the Province, and also operating deficits incurred in the provision of nursing homes and facilities. A 'hospital mill rate' is applied against all taxable and grant-in-lieu property.

Regional planning services for municipalities are provided through Regional Planning Commissions or directly by the Planning Services Branch of Alberta Municipal Affairs. All municipalities are requisitioned by the Province for a portion of regional planning costs. The requisition is calculated by the application of a provincially set mill rate (which varies depending upon the type and size of (municipality) to the municipality's equalized assessment.

B. Municipal Operating Revenue

A brief review of various revenue sources is given below:

Municipal Property Taxes

Property taxes for municipal purposes are applied against all taxable and grant-in-lieu (i.e. government) property in the municipality. The rate of taxation is determined annually by dividing the assessed value of taxable and grant-in-lieu

property by the property tax revenue required for municipal operations. Municipalities have the option of splitting the municipal mill rate so that the rate applied to non-residential and/or multi-family residential property is higher than that applied to single family residential property.

Special Assessments

This category includes frontage taxes, local improvement levies and special benefit charges.

Business Taxes

These include revenue from taxes levied upon rental value or per square foot value of non-residential, non-government buildings.

Sales of Goods and Services

All revenues (other than taxes) which accrue to a municipality for goods and services supplied to individuals, corporations, or governments for their use or consumption is recorded under this category.

Other Revenue from Own Sources

Other revenue is non-tax revenue which accrues to the municipality by the exercise of its powers and which is not covered by the preceding classification. It includes licenses, permits, fines, rentals; concession and franchises; return on investments and penalties and interest on tax arrears.

Unconditional Transfers

This category includes unconditional grants received from federal, provincial and other governments.

Conditional Grants

These include specific purpose transfers from other governments. In Alberta, the Provincial government in recent years has made increasingly large amounts of monies available to municipalities to carry out special tasks[3]

Own Transfers

The classification is provided to accommodate other revenue transactions. The principal categories are transfers from own reserves and allowances, transfers from other funds and transfers from own agencies.

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[3]A description of all provincial assistance programs is provided in Alberta Municipal Affairs, Alberta Municipal Assistance Programs (published annually).

Property Taxes for Requisitions

These include school, regional health and planning property taxes.

C. Municipal Capital Services

Revenues acquired or expenditures undertaken which result in the acquisition or construction of tangible assets are accounted in seperate capital funds.

D. Municipal Utility Services

Revenues and expenditures required for the provision of services operated as public utilities are accounted in seperate Utility Funds. For most municipalities, the water service is the only public utility but other services operated as public utilities by some municipalities include airports, gas, electricity and in Edmonton, telephones.

Appendix C

RESIDENTIAL PROPERTY ASSSESSMENT CARD SPECIMEN

(Side 1)

CODE ______________ THE CITY OF EDMONTON ASSESSOR'S DEPARTMENT ROLL NO. ______________

ADDRESS ______________________________ PLAN ______________

LOT ______________ BLOCK ______________ SUB-DIV. ______________

TYPE ________ DESCRIPTION ______________________________ GOOD ______________

FAIR ______________

CONSTRUCTION ______________________ ROOF ______________ POOR ______________

SINK	BASIN	SHOWER	F. PLACE
TOILET	BATH	CHIMNEY	HEAT

AGE	LIFE	OUT	IN	FUNC	ECON.

FLOOR NO.	FLOOR FINISH	TRIM	WALL FINISH	NO. OF ROOMS	CEILING HEIGHT	REMARKS	PLUS	MINUS

LENGTH X BREADTH	AREA	RATE	STRUCT'L VALUE		PLUS	MINUS
	CLASS	CONSTANT		CONST.		
X				SHAPE		
X				HEAT		
X				PLUMBING		
X				FLOORS & TRIM		
X				WALLS		
X				WINDOWS		
X				FIREPLACE		
X				B.ROOMS		
				MISC.		

ROLL YEAR	STRUCT'L	PHYSICAL DEPR	OTHER ADJUSTM'T.	APPRAISED VALUE	%	BUILDING ASS'M'T	INSP'T'N DATE	BY

RESIDENTIAL PROPERTY ASSESSMENT CARD SPECIMEN

(Side 2)

INSPECTION NOTES
CONDITION—EXCESS DEPRECIATION
ADDNS. ALT—IMPROVM'T'S--YEAR MADE

TO BE DATED AND INITIALED

PERMIT NO.	YEAR	AMOUNT	WORK	BY

SAMPLE MULTIPLE LISTINGS FORM

EXCLUSIVE AUTHORITY TO SELL, EXCHANGE AND/OR LEASE AGREEMENT

To: A.B.C. REALTY LTD., 123 DOWNTOWN STREET, ANYTOWN, ALBERTA Phone 261-2222

In consideration of your listing and offering for sale, exchange and/or lease the undermentioned property, as owner or authorized agent for the owner, I hereby give you the sole and exclusive listing thereof, with sole authority to dispose of the same irrevocably until and including the 31 day of August A.D. 19 7X, on the terms herein stated or as may be agreed upon.

LOCATION 123 - Able Street Lot 1 Block 2 Plan 1100 AB

Subject to the reservation, covenants, condition and exceptions contained in the existing Certificate of Title.

Owner(s) full Name(s) John D. & Mary A. Owner

POSSESSION – to be given ____ days from the date of Sale, Exchange or Lease, or ____ day of ____ 19__.
(Subject to the rights of tenants, if any).

PRICE $ 58,900.00 Cash Payment $ 32,700.00

1st Balance $ 26,200.00 End of Term August 31 19 77

Monthly payment of 289 including interest at 9 % Taxes (included) ~~(not included)~~ Yes 19__.

2nd Balance of ____ End of Term ____ 19__.

Monthly payment of ____ including interest ____ %.

The following appurtenances shall be included in the Price All attached fixtures, stove & all drapes.

Rental – (annual or monthly) ____ $ ____

Special Terms ____

I HEREBY AGREE AS follows.

SALE COMMISSION – to pay you a commission of six (6%) percent of the gross sale price

DEFAULT BY VENDOR – That if I shall fail for any reason whatever to complete a sale or exchange upon your procuring a purchaser ready, willing and able to complete a sale or exchange in accordance with this agreement or on such other terms as I may agree upon, to pay you a commission calculated in the manner hereinbefore provided

DEFAULT BY PURCHASER – That if a purchaser (as defined in the Interim Offer to Purchase) shall fail for any reason to complete a sale after acceptance by me by the said Interim Offer to Purchase and forfeits the deposit paid on the Interim Offer to Purchase, I agree to pay the lesser of (a), the full amount of commission calculated as if the sale had been completed or (b) half (½) of the forfeited deposit.

DEFINITION – That the word "lease" as herein used means a Lease either verbal or in writing.

LEASE COMMISSION – To pay a commission of ____ percent of the gross annual rental.

DEFAULT BY LESSEE – That if a lessee who offers to lease shall fail for any reason to complete a lease after acceptance by me of the Offer to Lease and forfeits the deposit paid I agree to pay the lesser of (a), the full amount of commission calculated as if the lease had been completed or (b) half (½) of the forfeited deposit.

MONTH-TO-MONTH TENANCY – That notwithstanding anything herein otherwise contained, in the event of a month-to-month tenancy is created under the authority of this listing, to pay you a commission of ____ percent.

PAYMENT OF COMMISSION – A commission which becomes payable by virtue of a lease or tenancy effected during the currency of this authority shall become due and payable on the date of execution of such lease if in writing and on the date of commencement of such lease or tenancy if verbal

AND I HEREBY CHARGE the aforesaid listed property with any commission earned in accordance with this Agreement. In consideration of your endeavours to sell, exchange or lease the said listed property and in the event of a sale, exchange or lease of the said listed property all necessary documents to be prepared at my expense.

DATED this 1 day of June 19 7X

John Salesman
(WITNESS)

OWNER John D. Owner
OWNER Mary A. Owner
Address 123 - Able Street
Phone: Res: 262-1234 Office 264-4321

Copy hereof received J.D.O. M.A.O.

# Exp. August 31/7X	Owner or Ten. Occ. Owner	Salesman John Salesman Bus. 261-2222 Res. 272-1122
Address 123 - Able Street	District Glenwood	No.

Zoning R-1
Rooms 6
Bedrs. 3
Suite Rumpus Room
City Approved ____

Lot Size 50 x 110
Landscaped Yes
Fenced Yes
Age 4 Possession 30 Days
Open Fireplace Yes
L. Rm. 12 x 20 Dining Rm. 9 x 9 Kitchen 9 x 14
Bedrooms 3 Sizes 10 x 12 10 x 10 9 x 9
Bath Rms. 2 Main 4 pc. Master 2 pc. Other 3 pc down

Style Bungalow
Ext. Fin. Stucco & siding
Floor Finish Brdlm. & Lino.
Size of Home 1180 sq. ft.
Heat Forced Air

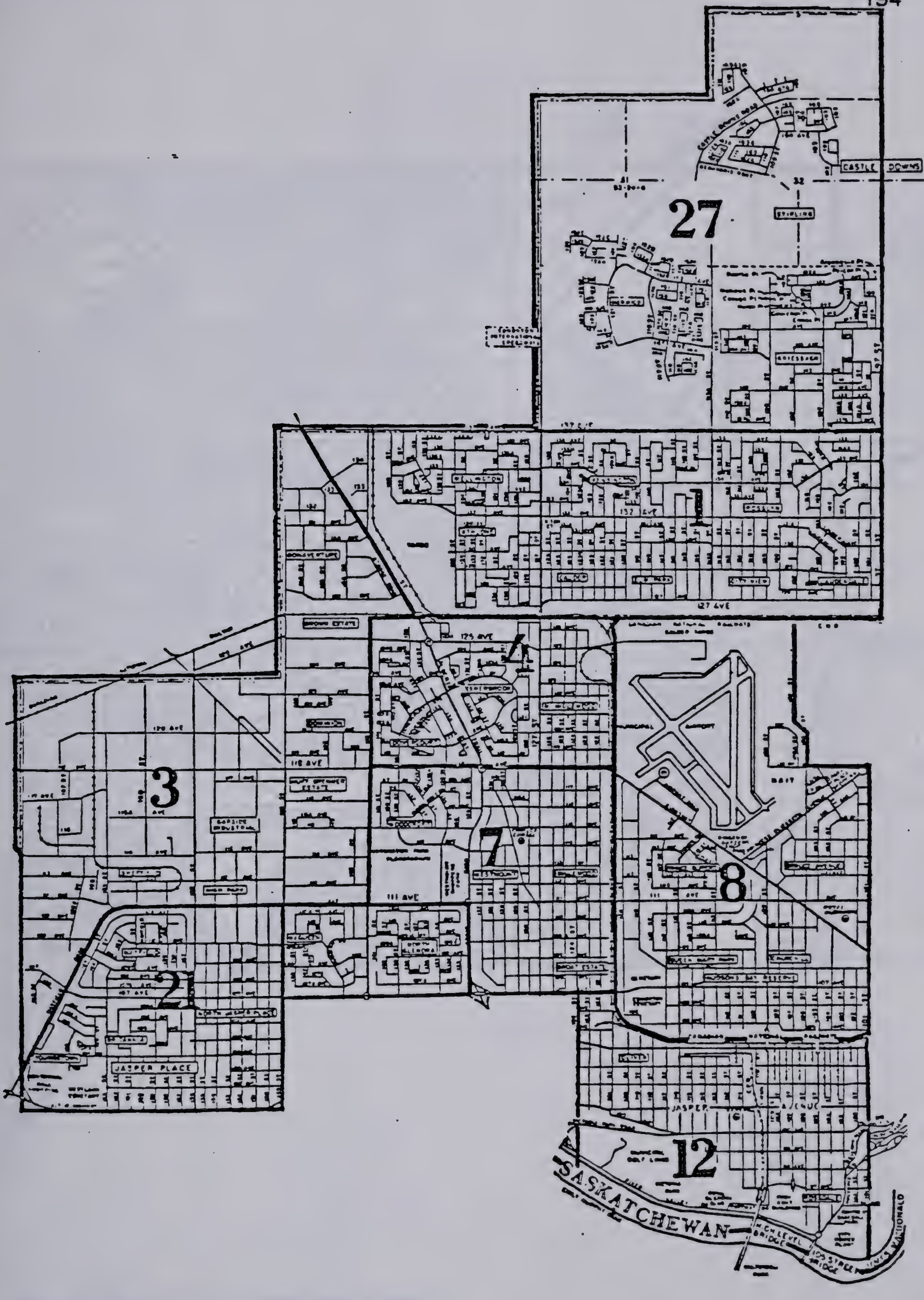
Price $ 58,900.00
Dwnpt. $ 32,700. Taxes 545.00
Mtg. $ 26,200.00 Int. 9 %
Term Ends August 1 19 77
Mtg. Pmts. $ 289.00 (PI or PIT)
Mtg. Co. XYZ Mortgage Company
A/S ____ Int. ____ %
Term Ends ____ 19 ____
Pmts on A/S ____
To ____
Appts. thru ____

2nd Floor N/A
Basement Full with rumpus room & bath
Garage Single detached at rear
Incl. in Price All attached fixtures, stove & drapes
Remarks: Heated garage, excellent development in basement
Private backyard with lots of trees & shrubs
Owner transferred

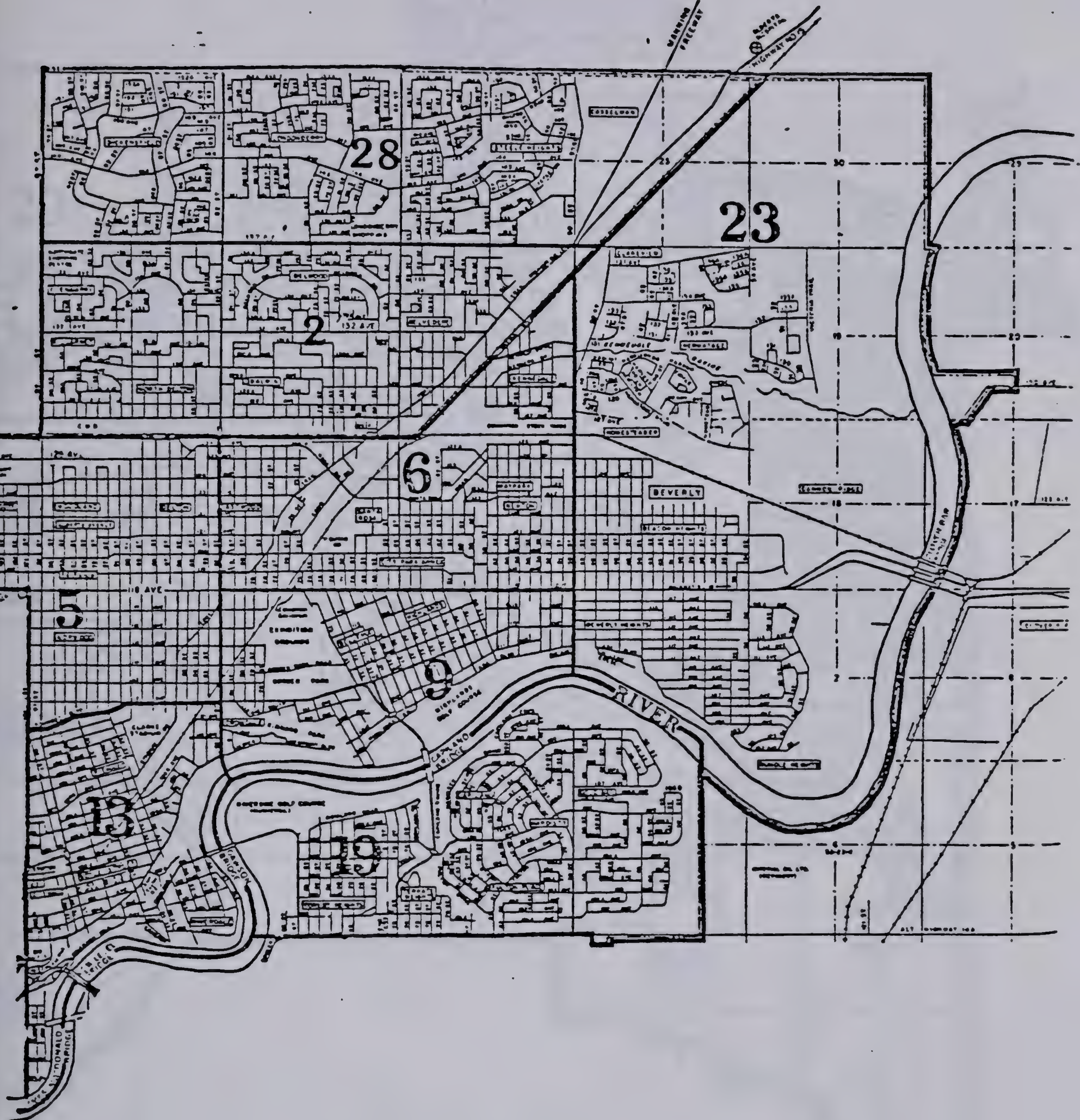
Owner J. D. & M.A. Owner Address 123 - Able Street Phone 262-1234
Date June 1/7X

Appendix E

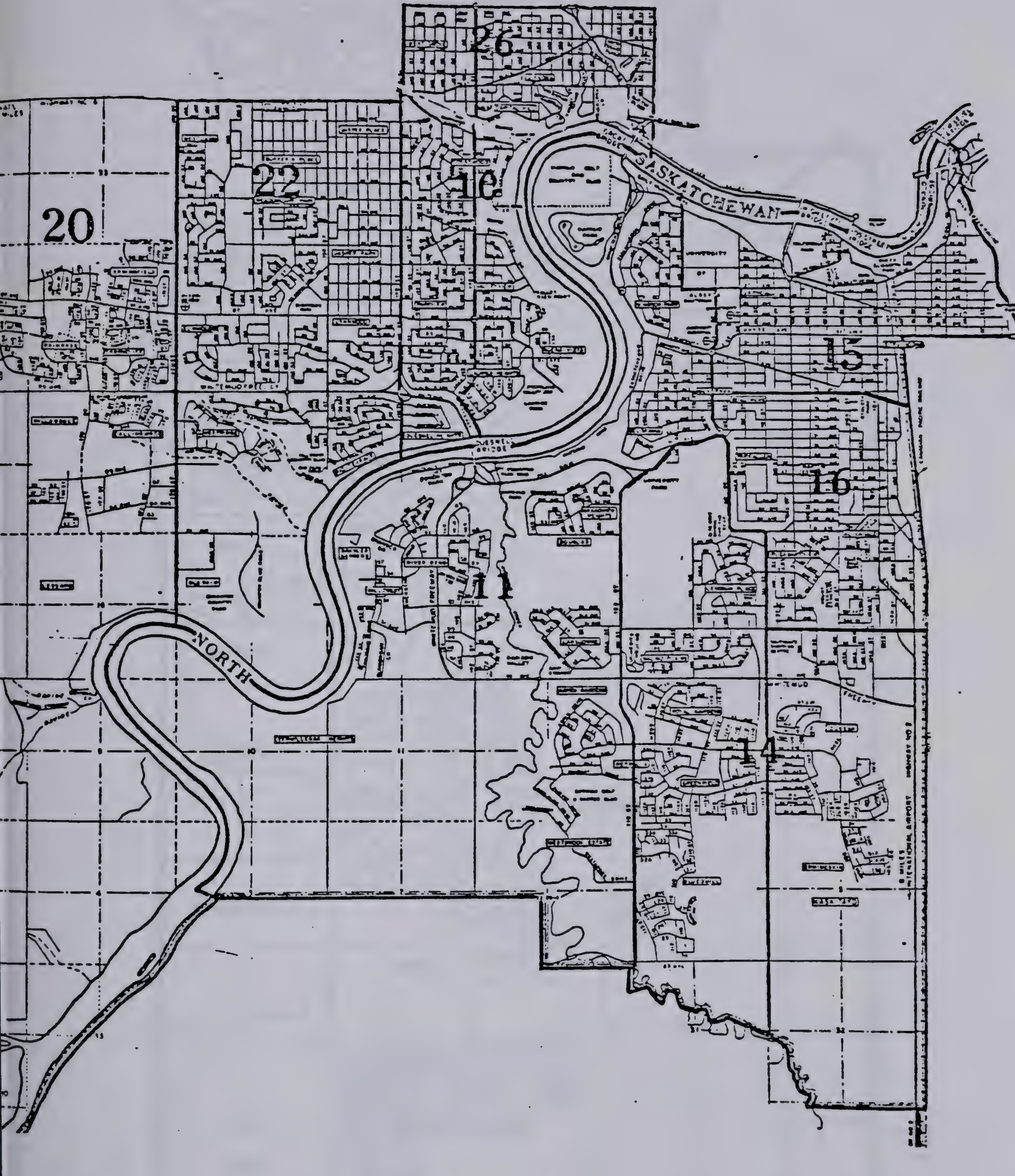
SELECTED MAPS



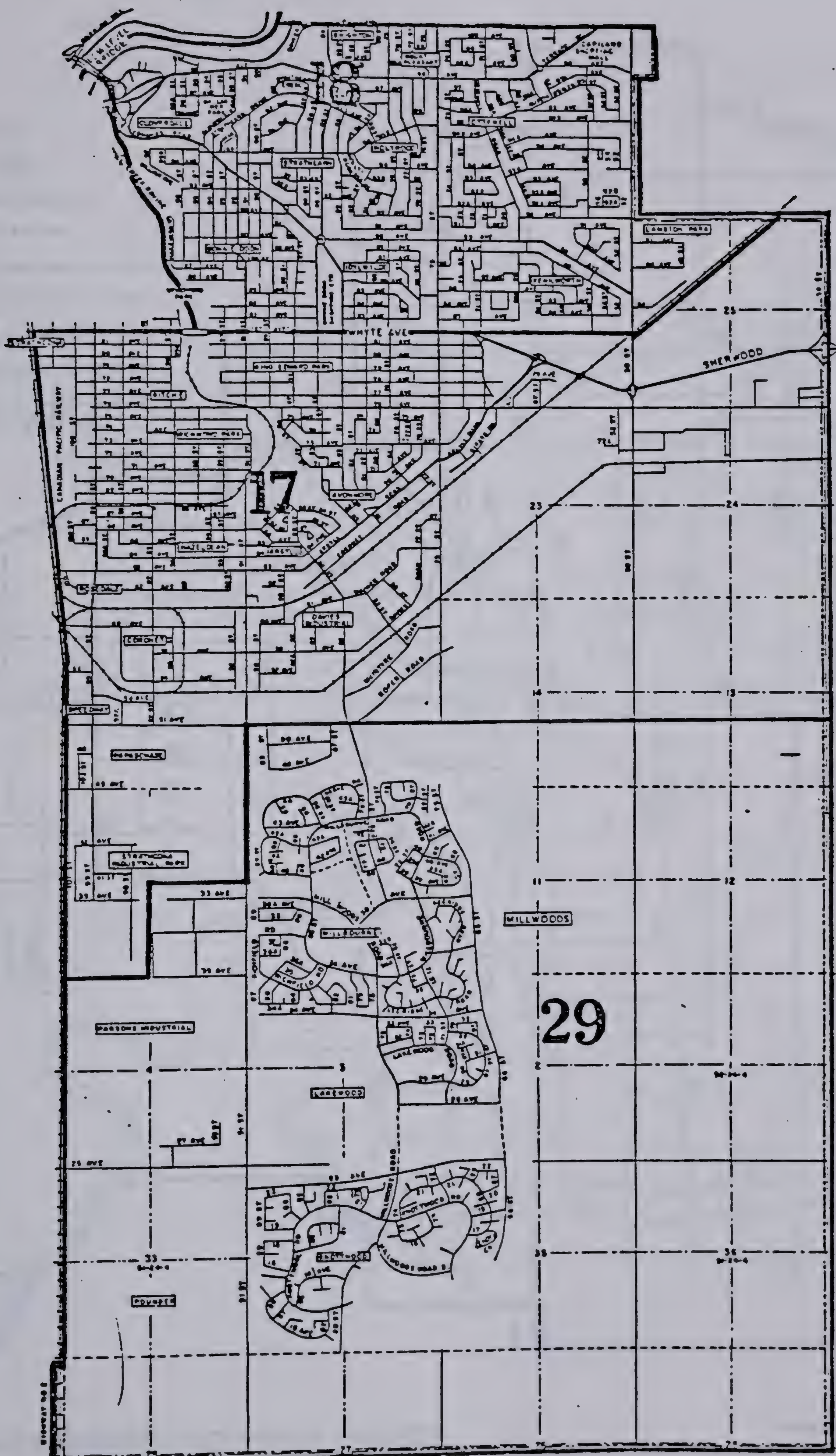
Map E.1 EDMONTON COMMUNITY ZONES



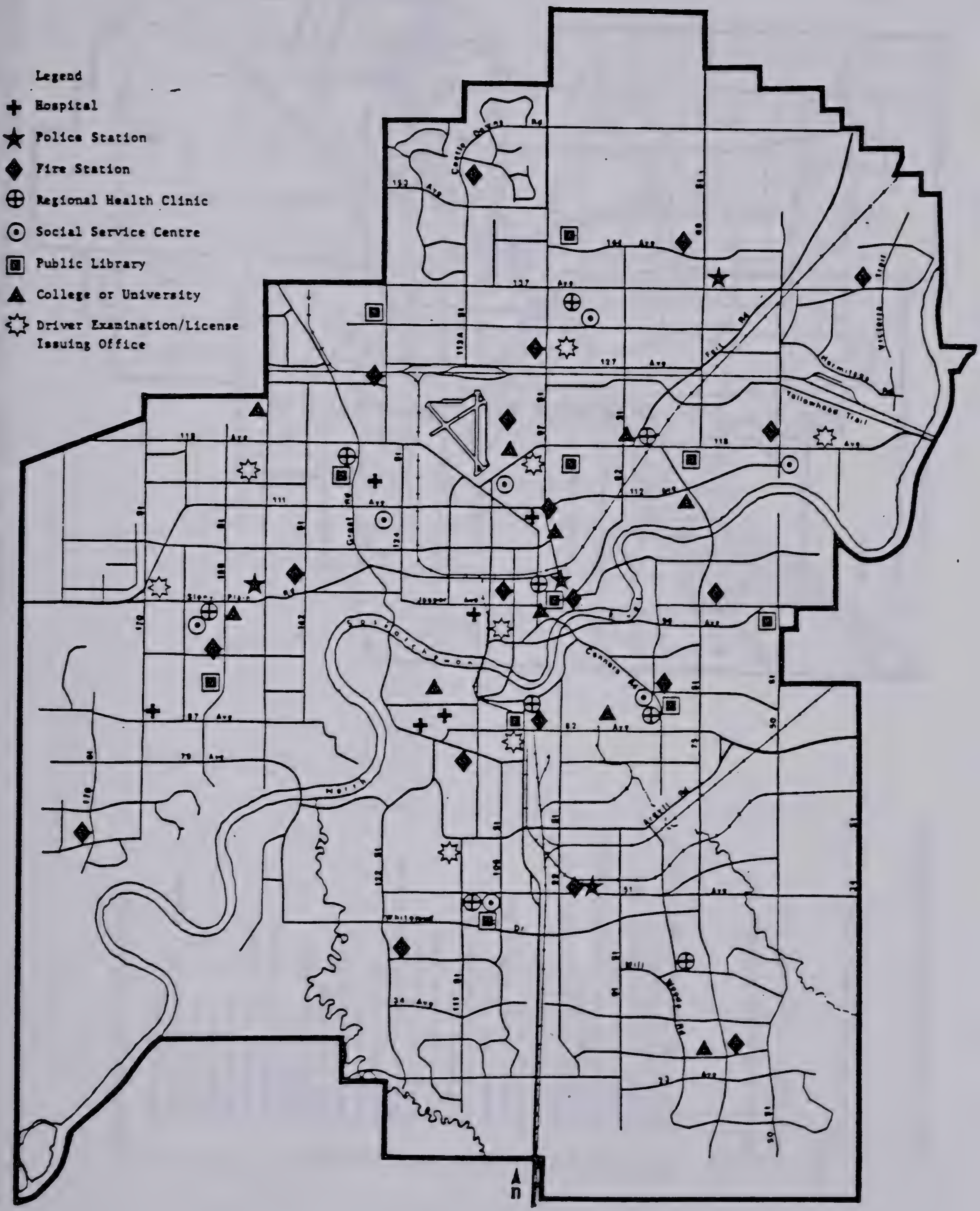
Map E.2 EDMONTON COMMUNITY ZONES



Map E.3 EDMONTON COMMUNITY ZONES



Map E.4 EDMONTON COMMUNITY ZONES



Map E.5 EDMONTON COMMUNITY FACILITIES

January 1980

Location of Major Parks Within the City of Edmonton

River Valley and Ravine System[1]

1 Hermitage Park
2 Rundle Park and Golf Course
3 Gold Bar Park
4 Floden Park
5 Capilano Park
6 Riverside Golf Course
7 Highlands Golf Course
8 Borden Park
9 Muttart Conservatory
10 Mill Creek Park
11 Queen Elizabeth Park
12 Kinsmen Park
13 Emily Murphy Park
14 Victoria Park and Golf Course
15 Mayfair Golf Course
16 William Hawrelak Park
17 Coronation Park
18 Norwester Industrial Park
19 Buena Vista Park
20 Laurier Park - Valley Zoo
21 Whitemud Park
22 Fort Edmonton Park
23 Edmonton Golf and Country Club
24 Terwillegar Park[2]
25 Whitemud Ravine - Rainbow Valley
26 Confederation Park
27 Derrick Golf and Winter Club
28 South Industrial Park
29 Mill Woods Park and Golf Course[2]

Note:

1 Includes Capital City Recreation Park

2 To be developed in the near future

Source:

Parks and Recreation Master Plan, 1979 - 1983

Map E.6 EDMONTON MAJOR PARKS

Appendix F

A LIST OF SAMPLE COMMUNITIES

Zone #	Communities
1	Wellington, Athlone,Kensington, Calder Lauderdale,Rosslyn
2	Glengarry, Killarney, Balwin, Delwood, Belvedere
3	Northwest
4	Sherbrooke, Prince Charles, Dovercourt
5	Alberta Avenue, Parkdale, Eastwood, Delton, Westwood
6	Montrose, Newton, Elmwood Park
7	Westwood, North Glenora, McQueen, Woodcroft, Inglewood
8	Central, Queen Mary, Prince Rupert, Spruce Avenue
9	Highland, Bellevue
10	Parkview, Laurier Heights, Quesnell Heights, Crestwood
11	Windsor Park, Belgravia, Grandview Heights, Brookside, Brauder Gardens Lansdowne, Aspen Gardens, Westbrooke
12	Oliver, Westmount(South), Rossdale
13	Boyle Street, McCauley, Downtown
14	Lendrum, Malmo Plains, Royal Gardens, Greenfield, Duggan, Rideau Park, Empire Park
15	Scona, Garneau
16	McKernan, Parkallen, Queen Alexandra, Allendale, Pleasant View
17	Ritchie, Hazeldean, Argyll, Avonmore, King Edward Park
18	Kenilworth, Idylwylde, Bonnie Doon, Cloverdale, Strathern, Holyrood, Ottewell
19	Forest Heights, Terrace Heights, Fulton Place, Capilano, Gold Bar
20	Bellmead, Summerlea, Aldergrove, Thorncliff, Lymburn, Callingwood Campus, Ormsby Place, Callingwood South, Gariepy
21	Jasper Place, Sherwood, West Jasper Place, Glenwood, Canora, Brittania Youngstown, High Park, Mayfield, Westgrove

22	Oleskiw, Westridge, Patricia Heights, Elmwood, Rio Terrace, Lynnwood, Meadowlark, West Meadowlark
23	Rundle Heights, Beverley Heights, Abbotsfield, Beacon Heights, Bergman, Homesteader, Belmont, Sifton Park
24	St.Albert
25	Sherwood Park
26	Glenora, Clifton Place, Woodbend Place
27	D.N.D. Griesbach, Stirling, Warwick, Castle Downs
28	McLeod, Casselman, Steel Heights, Londonderry, Kilkerney, Northmount, Evansdale, Dickens Field
29	Tweddle Place, Michaels Park, Richfield, Lee Ridge, Tipaskan, Kameyosek, Meyonohk, Campus, Satoo, Ekota, Menisa, Woodvale, Burnewood, Ridgewood
30	Spruce Grove
31	Leduc
32	Morinville
33	Fort Saskatchewan
34	Stony Plain
35	Devon

Appendix G

VARIABLES LIST

Abbreviation	Definition
A	Assessed value ($)
AC	Total number of occurances of all crimes
AGE	Age in years
AS	Achievement score
ASR	Assessment-sales ratio
BAPC	Per capita business assessment ($)
BATH	Number of 3 or 4-piece baths
BR	Number of bus routes
BRA	Bedrooms area in square feet
BROMS	Number of bedrooms
BRST	Dummy = 1 if exterior has a brick or stone finish.
DBUS	Distance to the nearest bus stop
DCBD	Distance to the central business district
DFR	A 0-1 dummy variable equal to 1 if the property has a recreation and/or family room.
DRA	Dining room area in square feet
DSCHL	Distance to a primary school
DSIZE	Dwelling size in square feet
DUP	Dummy = 1 if house is a duplex
FA	A binary variable equal to one if the house has a forced air heating system
FC	Fire classification
FP	Dummy = 1 if the property has a fireplace
FRA	Fiscal residuals - series A
FRB	Fiscal residuals - series B

FRC	Fiscal residuals – series C
FSR	Residential fire protection index = (1–RFC/HP)
GAI	General Accessibility Index
GAR	Garage size – in number of stalls
HP	Number of single family dwellings
i	time horizon
KRA	Kitchen area in square feet
LOCAL	Per capita local expenditures ($) = MUNC + SKL
LOC	Capitalized expenditure benefits based on LOCAL
LOCALA	LOCAL dummy for Spruce Grove, Leduc, Fort Saskatchewan
LOCALB	LOCAL dummy for Morinville, Stony Plain and Devon
LOCAL24	LOCAL dummy for St. Albert
LOCAL25	LOCAL dummy for Sherwood Park
LRA	Living room area in square feet
LSIZE	Lot size in square feet
MG	Municipal grants ($)
MUNC	Per capita municipal expenditures ($)
MT	Mean municipal effective tax rate
MT24	MT dummy for St. Albert
MTAX	Mean municipal tax bill per household ($)
MTAX24	MTAX dummy for St. Albert
NPSI	Neighbourhood property safety index
NSI	Neighbourhood safety index
NRA%	Non–residential assessment/Total assessment
OLD	Percent old (people over 65 years)
P	House sales price ($)
PARK	Park area
PBT	Per capita weekly bus trips
PC	Total number of property crimes
PCEA	Per capita equalized assessment ($)
PGR	Population growth rate

PKIS	Recreations programs index
POOR	Percent of families having income below $12,000
POP	Population
PPC	Per capita property crimes
PPD	Persons per dwelling
PSA	Capitalized expenditure benefits based on PSI – series A
PSB	Capitalized expenditure benefits based on PSI – series B
PSI	Public services index
PTC	Per capita total crimes
PTCE	Public transit capital expenditures ($)
PTOE	Public transit operating expenditures ($)
r	Discount rate
RFC	Residential fire count
RFL	Residential fire loss ($)
RFR	Residential fire rate
ROOMS	Number of rooms
RPK	Roads per kilometer of area
SCHL	Per pupil school expenditures
SKL	Per capita school expenditures
SITEI	Site characteristics index
STRUCI	Structural characteristics composite index
SYAFL	Six year average per capita fire loss ($)
SYAFR	Six year average fire rate
T	Effective tax rate (Mills)
t	Effective tax rate (TAX/P)
τ	Nominal tax rate
T24	T dummy for St. Albert
TA	Capitalized tax burden series A
TAX	Tax bill per household ($)
TAX24	TAX dummy for St. Albert
TAXDIF	TAX–MTAX

TAXDIF24	TAXDIF dummy for St. Albert
TB	Capitalized tax burden series B
TC	Capitalized tax burden series C
TMT	T - MT
TMT24	TMT dummy for St. Albert
TRANSIT	Public transit operating and capital expenditures ($)
TWO	Dummy = 1 if the property is a two-storey house
Y	Median family income
YOUNG	Percentage of people in the age group 0 to 19

Appendix H

AN OVERVIEW OF THE HEDONIC APPROACH

Our empirical approach rests on the use of hedonic prices to determine the impact of property taxes and public services on housing prices. This appendix presents a brief review of this concept and its applications.

The hedonic price function approach assumes that a commodity can be effectively disaggregated into a vector of seperately measurable characteristics each of which contributes to the value of the commodity. [1] This approach to the construction of price indices was first proposed by Adelman and Griliches in 1961. Their chief purpose was to correct consumer price indices for changes in the quality of constant basket of commodities. The emergence of the Lancastrian characteristics approach to consumer demand theory (Lancaster 1966) in which commodities were viewed as a bundle of attributes gave impetus to the use of this technique in economic analysis. [2] Hedonic models have since been used to generate implicit characteristics prices for automobiles, houses, refrigerators and computers, etc.

Griliches (1971) interprets hedonic coefficients as the market price per unit of an additional characteristic of the commodity. For continuously measurable characteristics regression coefficients represent marginal prices. Rosen (1974) demonstrated that a hedonic price function is a joint envelope of sellers' offer price functions and buyers' bid functions. In this framework the regression coefficient would reflect the market clearing price of a characteristic. [3]

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[1] The hedonic price function is a reduced form equation reflecting the interaction of supply and demand in the market for a commodity. It relates commodity characteristics to its price. More formally it can be defined as follows :

$$P = (H, u)$$

where P = observed price of a commodity say a house.
H = a set of specifications , attributes , characteristics determining the value of the commodity.
u = disturbance term.

[2] For a critique of this approach see Lave (1972, 1978), Smith (1976), Harris (1978) and Pearce and Edwards (1978).

[3] In a perfectly competitive market hedonic prices will reflect both marginal cost of production of an additional characteristic. Price ratios will reflect point estimates of equality of marginal rates of substitution (mrs) and transformation (mrt). Noto (1976a) argues that if competition does not prevail say on the seller side of the market , then prices do not necessarily reflect marginal costs though the interpretation of them as measures of marginal consumer evaluations remains valid. She states that in the housing market we generally face inelastic supply in a community, therefore, marginal cost interpretation of the characteristics prices will not be strictly valid. Further, unless we can identify a very homogenous community, coefficients in a linear regression may not be strictly interpreted as marginal rates of substitution of of an additional unit to a resident.

[3]

The hedonic technique has been extensively applied to environmental amenities where benefits and costs are believed to be capitalized into property values . These studies interpret marginal implicit prices obtained from a hedonic function as measures of marginal willingness to pay [4] but Freeman (1979) points out that such an interpretation is valid only if households have complete information, transactions costs are zero and the price vector adjusts instantaneously to changes in market conditions. [5]

To obtain better estimates of the true willingness to pay , environmental literature have now begun to employ multistage empirical procedures which are cosistent with Rosen's theoretical framework (1974) and incorporate the suggestions offered by Freeman (1979). Harrison and Rubinfeld (1978a), for instance, employed a two step estimation procedure to estimate the demand for air quality. In the first step the hedonic price equation was used to estimate the implicit price of the characteristic (air quality) and then in the second step this implicit price was regressed against observed quantities and household income to estimate inverse demand function or marginal willingness to pay function for air quality. McDougall (1976b) used a similar procedure to estimate the demand for municipal services. Linneman (1981) has carried this analysis a step further by employing the demand coefficients in conjunction with the joint distribution of household demand variables (income etc.) to obtain the vector of optimal characteristics demand for each household.

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[3](cont'd)Thus it would be more reasonable to consider the regression coefficient of a characteristic as the average market value obtained by that unit in the housing market. See Noto (1976a) and Lucas (1975).

[4] Ridker and Henning (1967) advanced this interpretation to estimate benefits of air pollution control. Polinsky and Shavell (1976) has demonstrated that such an interpretation would be valid only "if the area affected is small (in which case the property value at location i depends only on amenities at i) and open (that is , there is full mobility). In that case competitive bidding by households for preferred locations will result in land prices fully reflecting the value of differences in environmental quality" (McMillan, Reid and Gillen (1980), p.315).

[5] See Anderson and Crocker (1972), Freeman (1974), Polinsky and Shavell (1975) and Small (1975) for a critical review of Ridker-Henning appraoch. McMillan, Reid and Gillen (1980) summarize this debate.

Appendix I

CAPITALIZATION STUDIES – A SUMMARY

(a) Cross-Jurisdiction Differentials :

Author	Data	Results
Orr (1968)	31 municipalities in Boston Area 1959 aggregate data.	Evidence of capitalization in rental housing market. Also educational expenditures capitalized.
Oates (1969)	53 municipalities in Northeastern New Jersey 1960, 1963 aggregate data.	Evidence of almost full capitalization.
Hyman & Pasour (1973)	106 incoporated towns in North Carolina. 1970 aggregate data	No capitlization of property taxes but small capitalization of local expenditures.
Edel & Sclar (1974)	Municipalities in Boston Area. Aggregate data for various years (1930, 1940, 1950, 1960 & 1970)	Evidence of tax and expenditure capitalization.
Gustley (1976)	Cities and towns in Syracuse area. 1970 aggregate data.	Evidence of capitalization.
McDougall (1976)	35 communities in Los Angeles metropolitan area. Aggregate data.	Evidence of public services capitalization.
McMillan & Carlson (1977)	65 small cities in Wisconsin 1970 aggregate data.	No evidence of capitalization.

b)Within Jurisdiction Differentials :

Wicks, Little and Beck (1968)	Missoula County Montana, 1965–67.	Evidence of tax capitalization.
Smith (1970)	Sunset district San Fransisco, 1967.	Evidence of capitalization.
King (1973)	1892 single family homes	Evidence of

	New Haven, 1967-69.	capitalization.
Edelstein(1974)	2143 Multiple Listings transactions. Philadelphia 1967-69.	Evidence of tax capitalization.
Wales & Wiens (1974)	1800 sales of improved residential property.Surrey,B.C. 1972	No evidence of capitalization.
Noto (1976a)	17,300 single family dwellings sold in San Mateo, California 1971-73	Evidence of capitalization.
Chinloy (1978)	1,224 single family dwellings in London, Ontario. 1974 Housing Survey data.	No capitalization of effective tax rates net of tax credit.
Sonstellie & Portney (1980)	1453 single family homes sold in San Mateo California 1969-70	Evidence of capitalization.
Ihlandfeldt & Jackson (1982)	St. Louis, Missouri Annual Housing Survey data	Complete capitalization of tax differentials.
Johnson & Lea (1982)	923 Multiple Listings, Erie County, New York, 1978.	Weak Capitalization of taxes and public services.
(b) Both Cross-jurisdictional and Within Jurisdiction Differentials :		
Goodman (1982)	1835 single family houses in the New Haven SMSA, 1967-69.	Evidence of tax capitalization.
This study (1983)	875 single family homes sold in Edmonton, Alberta, Canada, 1977.	Evidence of complete capitalization of taxes but only partial capitalization of expenditures. Also draws efficiency and distributional implications.

Appendix J

DISTRIBUTIONAL CALCULATIONS – AN ILLUSTRATION

Consider equation 3.14 (Oates approach). The equation estimates that :

$$dP/dT = -1795.9$$

$$dP/dPSI = 7191.7$$

In step I, the mean capitalized tax burden and public sector benefits are obtained by multiplying the above regression coefficients of T and PSI by their respective mean values for each neighbourhood obtained from tables 2.11 and 5.7. Public sector benefit values are inflated by a factor of 1.7 to take into account services that were not included in PSI. These values are then annualized assuming a discount rate of 2% and life of housing stock as forty years. The annualization factor for given values of discount rate and time horizon are given in Cissell and Cissell (1977). Table J.1 reports these calculations.

In step II we classify the tax burden and expenditure benefit estimates by family income class (Table 5.2) using median family income of each neighbourhood obtained from Table 5.7. This procedure obtains the distributional results presented in Table J.2. These results could then be expressed as a proportion of family income using the sample median income values for each class.

Table J.1 DISTRIBUTIONAL CALCULATIONS: STEP I

Real Estate Zone	Tax Burden ($)	Public Sector Benefits ($)	Fiscal Residue ($)
1	508.29	304.69	-203.60
2	505.88	250.01	-255.87
3	542.72	232.18	-310.54
4	457.72	406.91	-50.809
5	526.52	410.19	-116.33
6	425.65	381.59	-44.062
7	480.28	504.96	24.687
8	447.89	392.77	-55.119
9	471.94	464.96	-6.9876
10	455.52	691.84	236.32
11	452.68	619.27	166.59
12	524.44	573.32	48.875
13	411.62	1,664.7	1,253.1
14	456.47	540.92	84.450
15	495.16	704.39	209.23
16	478.54	381.34	-97.194
17	463.19	444.18	-19.008
18	500.87	386.25	-114.62
19	491.90	279.20	-212.70
20	471.39	560.51	89.121
21	491.47	396.33	-95.134
22	464.67	450.21	-14.459
23	532.01	295.63	-236.37
26	486.65	863.41	376.76
27	557.90	489.21	-68.698
28	510.70	304.62	-206.08
29	540.60	504.83	-35.773

Table J.2 DISTRIBUTIONAL CALCULATIONS: STEP II

Family Income ($)	Tax Burden ($)	Public Sector Benefits ($)	Fiscal Residue ($)
Under $15,999	482.27	697.54	215.27
$16,000 - $17,999	484.13	462.31	-21.825
$18,000 - $19,999	517.73	392.19	-125.53
$20,000 - $21,999	499.71	422.05	-77.66
$22,000 - $23,999	502.97	505.28	2.31
$24,000 - $25,999	468.79	555.95	87.15
$26,000 - $27,999	478.25	674.92	196.67
$28,000 and over	465.90	673.56	207.66

The above results could then be expressed as a proportion of family income using median income for each class.

Appendix K

THE NET FISCAL INCIDENCE OF THE LOCAL PUBLIC SECTOR IN EDMONTON : FURTHER RESULTS

Table K.1 REFERENCE TABLE FOR FISCAL INCIDENCE CALCULATIONS

ALLOCATION BASIS LABEL	TAX BURDENS LABEL	EXPENDITURE BENEFITS LABEL	FISCAL RESIDUALS LABEL	BASIS OF DISTRIBUTIONAL RESULTS: REGRESSION EQUATION	MODEL	VARIABLES SET	
I A	TA	LOC	FRA	3.12	Oates I	ROOMS, DSIZE, LRA, AGE, FP, DFR, BATH, GAR, BRST, LSIZE, GAI, Y, T, T24, LOCAL (A)	
I B	TB	PSA	FRB	3.14	Oates I	ROOMS to T24, PSI	(B)
I C	TC	PSB	FRC	3.61	Oates I	STRUCI, SITEI, PSI, T, T24	(C)
II A	TA	LOC	FRA	3.101	Oates II	ROOMS to Y as in (A) and TMT, MT, TMT24, MT24, LOCAL	(D)
II B	TB	PSA	FRB	3.103	Oates II	As above except LOCAL replaced by PSI	(E)
II C	TC	PSB	FRC	3.121	Oates II	STRUCI, SITEI, PSI, TMT, MT, TMT24, MT24, PSI	(F)
III A	TB	LOC	FRA	4.12	King-Reinhard I	T, T24 replaced by TAX and TAX24 in (A)	
III B	TB	PSA	FRB	4.14	King-Reinhard I	T, T24 replaced by TAX and TAX24 in (B)	
III C	TC	PSB	FRC	4.22	King-Reinhard I	T, T24 replaced by TAX and TAX24 in (C)	
IV A	TA	LOC	FRA	4.42	King-Reinhard II	TMT, MT, TMT24, MT24 replaced by TAXDIF, MTAX, TAXDIF24, MTAX24 in (D)	
IV B	TB	PSA	FRB	4.43	King-Reinhard II	As above except LOCAL replaced by PSI	
IV C	TC	PSB	FRC	4.52	King-Reinhard II	STRUCI, SITEI, PSI, TAXDIF, MTAX, TAXDIF24, MTAX24, PSI	

Table K.2 REVEALED TAX BURDENS AND EFFECTIVE TAX RATES BY FAMILY INCOME CLASS (Oates-type Regressions)

I. Oates I

Income Class	TA	TA/Y	TB	TB/Y	TC	TC/Y
1	521.40	0.34913E-01	482.27	0.32293E-01	468.12	0.31346E-01
2	523.41	0.30431E-01	484.13	0.28147E-01	469.93	0.27321E-01
3	559.73	0.28918E-01	517.73	0.26748E-01	502.54	0.25963E-01
4	540.25	0.25783E-01	499.71	0.23848E-01	485.04	0.23148E-01
5	543.78	0.22880E-01	502.97	0.21163E-01	488.21	0.20542E-01
6	506.83	0.20115E-01	468.79	0.18606E-01	455.04	0.18060E-01
7	517.05	0.18825E-01	478.25	0.17413E-01	464.22	0.16902E-01
8	503.70	0.12779E-01	465.90	0.11820E-01	452.23	0.11473E-01

VARIABLE NAME	MEAN	STANDARD DEVIATION	VARIANCE	MINIMUM	MAXIMUM
TA	527.02	19.351	374.47	503.70	559.73
TAY	0.24331E-01	0.71312E-02	0.50854E-04	0.12779E-01	0.34913E-01
TB	487.47	17.899	320.38	465.90	517.73
TBY	0.22505E-01	0.65961E-02	0.43508E-04	0.11820E-01	0.32293E-01
TC	473.16	17.374	301.85	452.23	502.54
TCY	0.21844E-01	0.64025E-02	0.40992E-04	0.11473E-01	0.31346E-01

II. Oates II

1	110.78	0.74180E-02	455.77	0.30519E-01	398.06	0.26654E-01
2	113.06	0.65734E-02	457.69	0.26610E-01	399.90	0.23250E-01
3	154.16	0.79646E-02	492.30	0.25434E-01	433.17	0.22379E-01
4	132.11	0.63049E-02	473.73	0.22608E-01	415.32	0.19821E-01
5	136.11	0.57269E-02	477.10	0.20075E-01	418.55	0.17611E-01
6	94.293	0.37424E-02	441.89	0.17538E-01	384.71	0.15269E-01
7	105.87	0.38544E-02	451.63	0.16443E-01	394.08	0.14348E-01
8	90.755	0.23025E-02	438.91	0.11135E-01	381.85	0.96876E-02

VARIABLE NAME	MEAN	STANDARD DEVIATION	VARIANCE	MINIMUM	MAXIMUM
TA	117.14	21.899	479.56	90.755	154.16
TAY	0.54859E-02	0.19865E-02	0.39463E-05	0.23025E-02	0.79646E-02
TB	461.13	18.438	339.97	438.91	492.30
TBY	0.21295E-01	0.62627E-02	0.39221E-04	0.11135E-01	0.30519E-01
TC	403.21	17.724	314.13	381.85	433.17
TCY	0.18627E-01	0.55013E-02	0.30264E-04	0.96876E-02	0.26654E-01

Table K.3 REVEALED TAX BURDENS AND EFFECTIVE TAX RATES BY FAMILY INCOME CLASS (King-Reinhard Approach)

III. King-Reinhard I

Income Class	TA	TA/Y	TB	TB/Y	TC	TC/Y
1	917.58	0.61442E-01	899.04	0.60201E-01	952.80	0.63801E-01
2	815.02	0.47385E-01	798.55	0.46427E-01	846.30	0.49204E-01
3	868.13	0.44851E-01	850.59	0.43945E-01	901.45	0.46572E-01
4	871.79	0.41605E-01	854.18	0.40765E-01	905.26	0.43202E-01
5	1047.6	0.44081E-01	1026.5	0.43190E-01	1087.8	0.45773E-01
6	948.72	0.37653E-01	929.55	0.36893E-01	985.13	0.39099E-01
7	1005.5	0.36609E-01	985.18	0.35869E-01	1044.1	0.38014E-01
8	967.03	0.24534E-01	947.50	0.24038E-01	1004.2	0.25476E-01

VARIABLE NAME	MEAN	STANDARD DEVIATION	VARIANCE	MINIMUM	MAXIMUM
TA	930.17	77.317	5977.9	815.02	1047.6
TAY	0.42270E-01	0.10502E-01	0.11029E-03	0.24534E-01	0.61442E-01
TB	911.38	75.755	5738.9	798.55	1026.5
TBY	0.41416E-01	0.10290E-01	0.10588E-03	0.24038E-01	0.60201E-01
TC	965.88	80.285	6445.7	846.30	1087.8
TCY	0.43892E-01	0.10905E-01	0.11892E-03	0.25476E-01	0.63801E-01

IV. King-Reinhard II

1	905.58	0.60639E-01	774.35	0.51851E-01	384.28	0.25732E-01
2	785.82	0.45687E-01	673.44	0.39154E-01	297.67	0.17307E-01
3	847.84	0.43802E-01	725.70	0.37492E-01	342.52	0.17696E-01
4	852.12	0.40666E-01	729.30	0.34805E-01	345.62	0.16494E-01
5	1057.4	0.44493E-01	902.28	0.37965E-01	494.09	0.20790E-01
6	941.94	0.37384E-01	804.98	0.31949E-01	410.57	0.16295E-01
7	1008.2	0.36708E-01	860.84	0.31342E-01	458.52	0.16694E-01
8	963.32	0.24440E-01	823.00	0.20880E-01	426.04	0.10809E-01

VARIABLE NAME	MEAN	STANDARD DEVIATION	VARIANCE	MINIMUM	MAXIMUM
TA	920.29	90.281	8150.7	785.82	1057.4
TAY	0.41728E-01	0.10207E-01	0.10419E-03	0.24440E-01	0.60639E-01
TB	786.74	76.068	5786.3	673.44	902.28
TBY	0.35680E-01	0.87394E-02	0.76376E-04	0.20880E-01	0.51851E-01
TC	394.91	65.290	4262.8	297.67	494.09
TCY	0.17727E-01	0.42450E-02	0.18020E-04	0.10809E-01	0.25732E-01

Table K.4 REVEALED PUBLIC SECTOR BENEFITS AND EFFECTIVE BENEFITS RATES BY FAMILY INCOME CLASS (Oates-type Regressions)

I. Oates I

Income Class	LOC	LOC/Y	PSA	PSA/Y	PSB	PSB/Y
1	642.59	0.43028E-01	697.54	0.46708E-01	606.99	0.40645E-01
2	642.59	0.37360E-01	462.31	0.26878E-01	402.30	0.23390E-01
3	642.59	0.33198E-01	392.19	0.20262E-01	341.29	0.17632E-01
4	642.59	0.30667E-01	422.05	0.20142E-01	367.27	0.17527E-01
5	642.59	0.27038E-01	505.28	0.21261E-01	439.70	0.18501E-01
6	642.59	0.25504E-01	555.95	0.22065E-01	483.78	0.19201E-01
7	642.59	0.23396E-01	674.92	0.24573E-01	587.31	0.21383E-01
8	642.59	0.16303E-01	673.56	0.17089E-01	586.13	0.14870E-01

VARIABLE NAME	MEAN	STANDARD DEVIATION	VARIANCE	MINIMUM	MAXIMUM
LOC	642.59	0.81562E-05	0.66523E-10	642.59	642.59
LOCY	0.29562E-01	0.83944E-02	0.70466E-04	0.16303E-01	0.43028E-01
PSA	547.98	121.66	14801.	392.19	697.54
PSAY	0.24872E-01	0.93048E-02	0.86579E-04	0.17089E-01	0.46708E-01
PSB	476.85	105.87	11208.	341.29	606.99
PSBY	0.21644E-01	0.80970E-02	0.65561E-04	0.14870E-01	0.40645E-01

II. Oates II

1	704.01	0.47141E-01	698.00	0.46739E-01	607.50	0.40679E-01
2	704.01	0.40931E-01	462.62	0.26896E-01	402.64	0.23409E-01
3	704.01	0.36372E-01	392.46	0.20276E-01	341.57	0.17647E-01
4	704.01	0.33598E-01	422.33	0.20155E-01	367.57	0.17542E-01
5	704.01	0.29623E-01	505.62	0.21275E-01	440.06	0.18516E-01
6	704.01	0.27941E-01	556.32	0.22080E-01	484.19	0.19217E-01
7	704.01	0.25632E-01	675.37	0.24589E-01	587.80	0.21401E-01
8	704.01	0.17861E-01	674.01	0.17100E-01	586.62	0.14883E-01

VARIABLE NAME	MEAN	STANDARD DEVIATION	VARIANCE	MINIMUM	MAXIMUM
LOC	704.01	0.18238E-04	0.33262E-09	704.01	704.01
LOCY	0.32387E-01	0.91968E-02	0.84582E-04	0.17861E-01	0.47141E-01
PSA	548.34	121.74	14820.	392.46	698.00
PSAY	0.24889E-01	0.93110E-02	0.86694E-04	0.17100E-01	0.46739E-01
PSB	477.24	105.95	11226.	341.57	607.50
PSBY	0.21662E-01	0.81037E-02	0.65670E-04	0.14883E-01	0.40679E-01

Table K.5 REVEALED PUBLIC SECTOR BENEFITS AND EFFECTIVE BENEFITS RATES BY FAMILY INCOME CLASS (King-Reinhard Approach)

III. King-Reinhard I

Income Class	LOC	LOC/Y	PSA	PSA/Y	PSB	PSB/Y
1	883.56	0.59164E-01	882.00	0.59060E-01	785.06	0.52569E-01
2	883.56	0.51370E-01	584.57	0.33987E-01	520.32	0.30251E-01
3	883.56	0.45648E-01	495.91	0.25621E-01	441.41	0.22805E-01
4	883.56	0.42166E-01	533.66	0.25468E-01	475.01	0.22669E-01
5	883.56	0.37177E-01	638.91	0.26883E-01	568.69	0.23929E-01
6	883.56	0.35067E-01	702.97	0.27900E-01	625.71	0.24834E-01
7	883.56	0.32169E-01	853.41	0.31071E-01	759.61	0.27656E-01
8	883.56	0.22416E-01	851.69	0.21608E-01	758.08	0.19233E-01

VARIABLE NAME	MEAN	STANDARD DEVIATION	VARIANCE	MINIMUM	MAXIMUM
LOC	883.56	0.22337E-04	0.49892E-09	883.56	883.56
LOCY	0.40647E-01	0.11542E-01	0.13323E-03	0.22416E-01	0.59164E-01
PSA	692.89	153.83	23664.	495.91	882.00
PSAY	0.31450E-01	0.11765E-01	0.13843E-03	0.21608E-01	0.59060E-01
PSB	616.73	136.92	18748.	441.41	785.06
PSBY	0.27993E-01	0.10472E-01	0.10967E-03	0.19233E-01	0.52569E-01

IV. King-Reinhard II

1	1540.3	0.10314	893.43	0.59825E-01	646.08	0.43262E-01
2	1540.3	0.89553E-01	592.14	0.34427E-01	428.21	0.24896E-01
3	1540.3	0.79578E-01	502.34	0.25953E-01	363.26	0.18768E-01
4	1540.3	0.73509E-01	540.58	0.25798E-01	390.92	0.18656E-01
5	1540.3	0.64812E-01	647.19	0.27232E-01	468.01	0.19692E-01
6	1540.3	0.61133E-01	712.08	0.28262E-01	514.94	0.20437E-01
7	1540.3	0.56081E-01	864.46	0.31474E-01	625.13	0.22760E-01
8	1540.3	0.39078E-01	862.72	0.21888E-01	623.88	0.15828E-01

VARIABLE NAME	MEAN	STANDARD DEVIATION	VARIANCE	MINIMUM	MAXIMUM
LOC	1540.3	0.46138E-04	0.21287E-08	1540.3	1540.3
LOCY	0.70861E-01	0.20122E-01	0.40489E-03	0.39078E-01	0.10314
PSA	701.87	155.82	24281.	502.34	893.43
PSAY	0.31857E-01	0.11918E-01	0.14204E-03	0.21888E-01	0.59825E-01
PSB	507.55	112.68	12698.	363.26	646.08
PSBY	0.23037E-01	0.86184E-02	0.74277E-04	0.15828E-01	0.43262E-01

Table K.6 FISCAL RESIDUALS AND EFFECTIVE INCIDENCE RATE BY FAMILY INCOME CLASS (Oates-type Regressions)

I. Oates I

Income Class	FRA	FRA/Y	FRB	FRB/Y	FRC	FRC/Y
1	121.19	0.81151E-02	215.27	0.14415E-01	138.88	0.92993E-02
2	119.17	0.69287E-02	-21.825	-0.12689E-02	-67.627	-0.39318E-02
3	82.856	0.42806E-02	-125.53	-0.64855E-02	-161.25	-0.83307E-02
4	102.34	0.48840E-02	-77.656	-0.37060E-02	-117.78	-0.56207E-02
5	98.811	0.41577E-02	2.3139	0.97363E-04	-48.514	-0.20413E-02
6	135.76	0.53882E-02	87.154	0.34591E-02	28.748	0.11410E-02
7	125.53	0.45705E-02	196.67	0.71603E-02	123.09	0.44817E-02
8	138.89	0.35236E-02	207.66	0.52684E-02	133.90	0.33971E-02

VARIABLE NAME	MEAN	STANDARD DEVIATION	VARIANCE	MINIMUM	MAXIMUM
FRA	115.57	19.351	374.47	82.856	138.89
FRAY	0.52311E-02	0.15470E-02	0.23931E-05	0.35236E-02	0.81151E-02
FRB	60.506	135.60	18388.	-125.53	215.27
FRBY	0.23674E-02	0.66692E-02	0.44478E-04	-0.64855E-02	0.14415E-01
FRC	3.6818	119.45	14269.	-161.25	138.88
FRCY	-0.20067E-03	0.58518E-02	0.34243E-04	-0.83307E-02	0.92993E-02

II. Oates II

1	593.23	0.39723E-01	242.23	0.16220E-01	209.44	0.14025E-01
2	590.95	0.34357E-01	4.9251	0.28635E-03	2.7321	0.15885E-03
3	549.85	0.28407E-01	-99.842	-0.51582E-02	-91.597	-0.47322E-02
4	571.90	0.27293E-01	-51.402	-0.24531E-02	-47.750	-0.22788E-02
5	567.90	0.23896E-01	28.525	0.12003E-02	21.508	0.90501E-03
6	609.72	0.24199E-01	114.43	0.45416E-02	99.474	0.39480E-02
7	598.14	0.21778E-01	223.74	0.81459E-02	193.72	0.70532E-02
8	613.25	0.15559E-01	235.10	0.59646E-02	204.77	0.51951E-02

VARIABLE NAME	MEAN	STANDARD DEVIATION	VARIANCE	MINIMUM	MAXIMUM
FRA	586.87	21.899	479.56	549.85	613.26
FRAY	0.26901E-01	0.74992E-02	0.56238E-04	0.15559E-01	0.39723E-01
FRB	87.212	136.12	18528.	-99.842	242.23
FRBY	0.35934E-02	0.67241E-02	0.45213E-04	-0.51582E-02	0.16220E-01
FRC	74.038	119.83	14358.	-91.597	209.44
FRCY	0.30342E-02	0.59014E-02	0.34827E-04	-0.47322E-02	0.14025E-01

Table K.7 FISCAL RESIDUALS AND EFFECTIVE INCIDENCE RATE BY FAMILY INCOME CLASS (King–Reinhard Approach)

III. King-Reinhard I

Income Class	FRA	FRA/Y	FRB	FRB/Y	FRC	FRC/Y
1	-34.025	-0.22784E-02	-17.040	-0.11410E-02	-167.74	-0.11232E-01
2	68.539	0.39848E-02	-213.98	-0.12441E-01	-325.98	-0.18952E-01
3	15.425	0.79693E-03	-354.68	-0.18324E-01	-460.05	-0.23768E-01
4	11.762	0.56134E-03	-320.52	-0.15296E-01	-430.25	-0.20533E-01
5	-164.06	-0.69032E-02	-387.54	-0.16307E-01	-519.14	-0.21844E-01
6	-65.161	-0.25862E-02	-226.58	-0.89926E-02	-359.43	-0.14265E-01
7	-121.94	-0.44396E-02	-131.78	-0.47978E-02	-284.48	-0.10358E-01
8	-83.476	-0.21178E-02	-95.807	-0.24307E-02	-246.07	-0.62430E-02

VARIABLE NAME	MEAN	STANDARD DEVIATION	VARIANCE	MINIMUM	MAXIMUM
FRA	-46.617	77.317	5977.9	-164.06	68.539
FRAY	-0.16228E-02	0.33698E-02	0.11356E-04	-0.69032E-02	0.39848E-02
FRB	-218.49	131.35	17254.	-387.54	-17.040
FRBY	-0.99662E-02	0.66216E-02	0.43845E-04	-0.18324E-01	-0.11410E-02
FRC	-349.14	117.19	13733.	-519.14	-167.74
FRCY	-0.15899E-01	0.62843E-02	0.39493E-04	-0.23768E-01	-0.62430E-02

IV. King-Reinhard II

Income Class	FRA	FRA/Y	FRB	FRB/Y	FRC	FRC/Y
1	634.73	0.42503E-01	119.08	0.79740E-02	261.80	0.17530E-01
2	754.50	0.43866E-01	-81.297	-0.47266E-02	130.53	0.75892E-02
3	692.48	0.35776E-01	-223.36	-0.11539E-01	20.740	0.10715E-02
4	688.20	0.32843E-01	-188.72	-0.90065E-02	45.300	0.21619E-02
5	482.89	0.20319E-01	-255.10	-0.10734E-01	-26.079	-0.10973E-02
6	598.38	0.23749E-01	-92.900	-0.36871E-02	104.36	0.41421E-02
7	532.08	0.19372E-01	3.6221	0.13188E-03	166.61	0.60662E-02
8	576.99	0.14639E-01	39.724	0.10078E-02	197.84	0.50192E-02

VARIABLE NAME	MEAN	STANDARD DEVIATION	VARIANCE	MINIMUM	MAXIMUM
FRA	620.03	90.281	8150.7	482.89	754.50
FRAY	0.29133E-01	0.11121E-01	0.12368E-03	0.14639E-01	0.43866E-01
FRB	-84.868	133.08	17710.	-255.10	119.08
FRBY	-0.38225E-02	0.66885E-02	0.44736E-04	-0.11539E-01	0.79740E-02
FRC	112.64	96.386	9290.3	-26.079	261.80
FRCY	0.53104E-02	0.56756E-02	0.32212E-04	-0.10973E-02	0.17530E-01

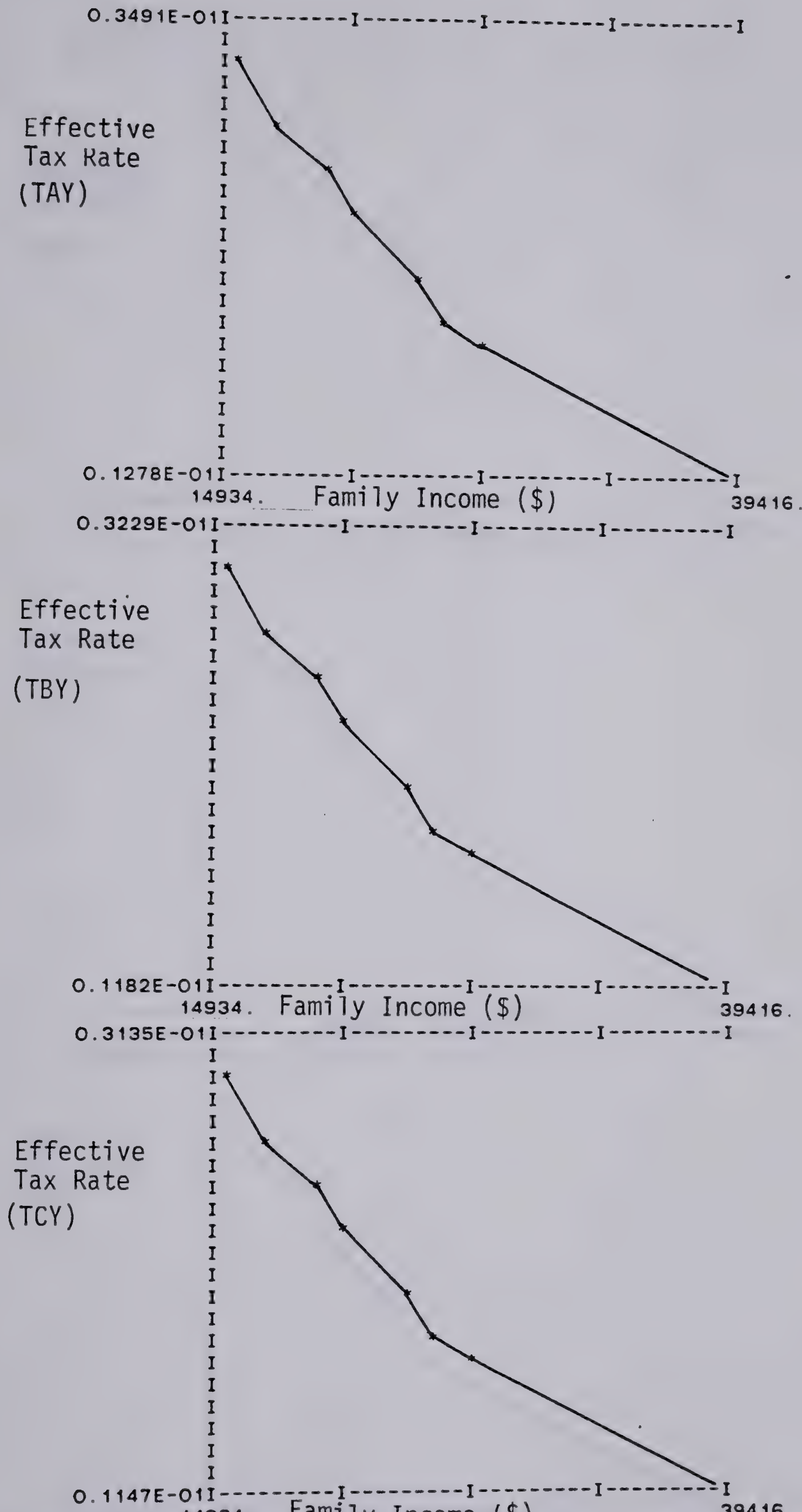


Figure K.1 THE DISTRIBUTION OF TAX BURDENS BY FAMILY INCOME CLASS

(Effective Tax Rates – Oates I)

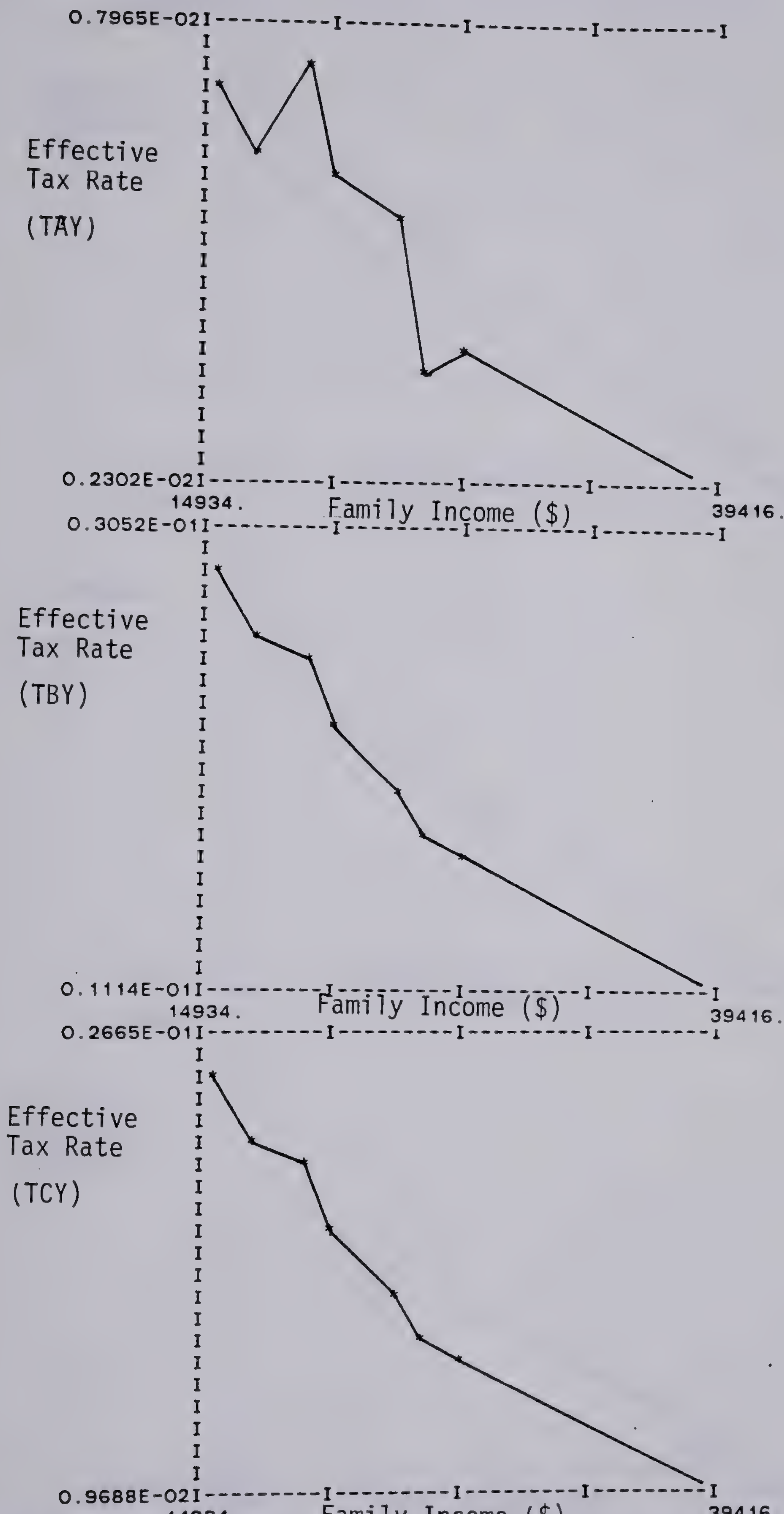


Figure K.2 THE DISTRIBUTION OF TAX BURDENS BY FAMILY INCOME CLASS

(Effective Tax Rates – Oates II)

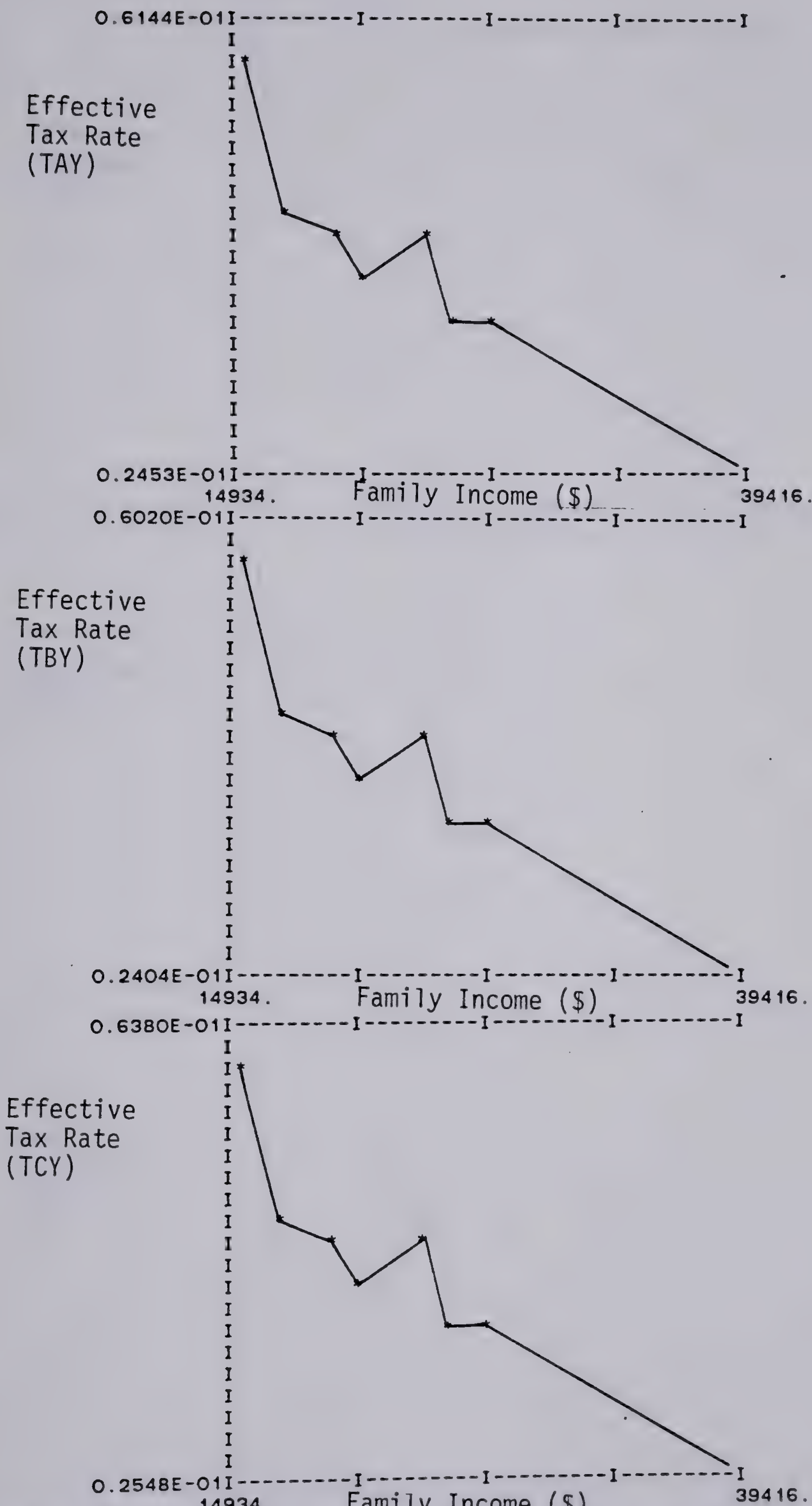


Figure K.3 THE DISTRIBUTION OF TAX BURDENS BY FAMILY INCOME CLASS

(Effective Tax Rates – King-Reinhard I)

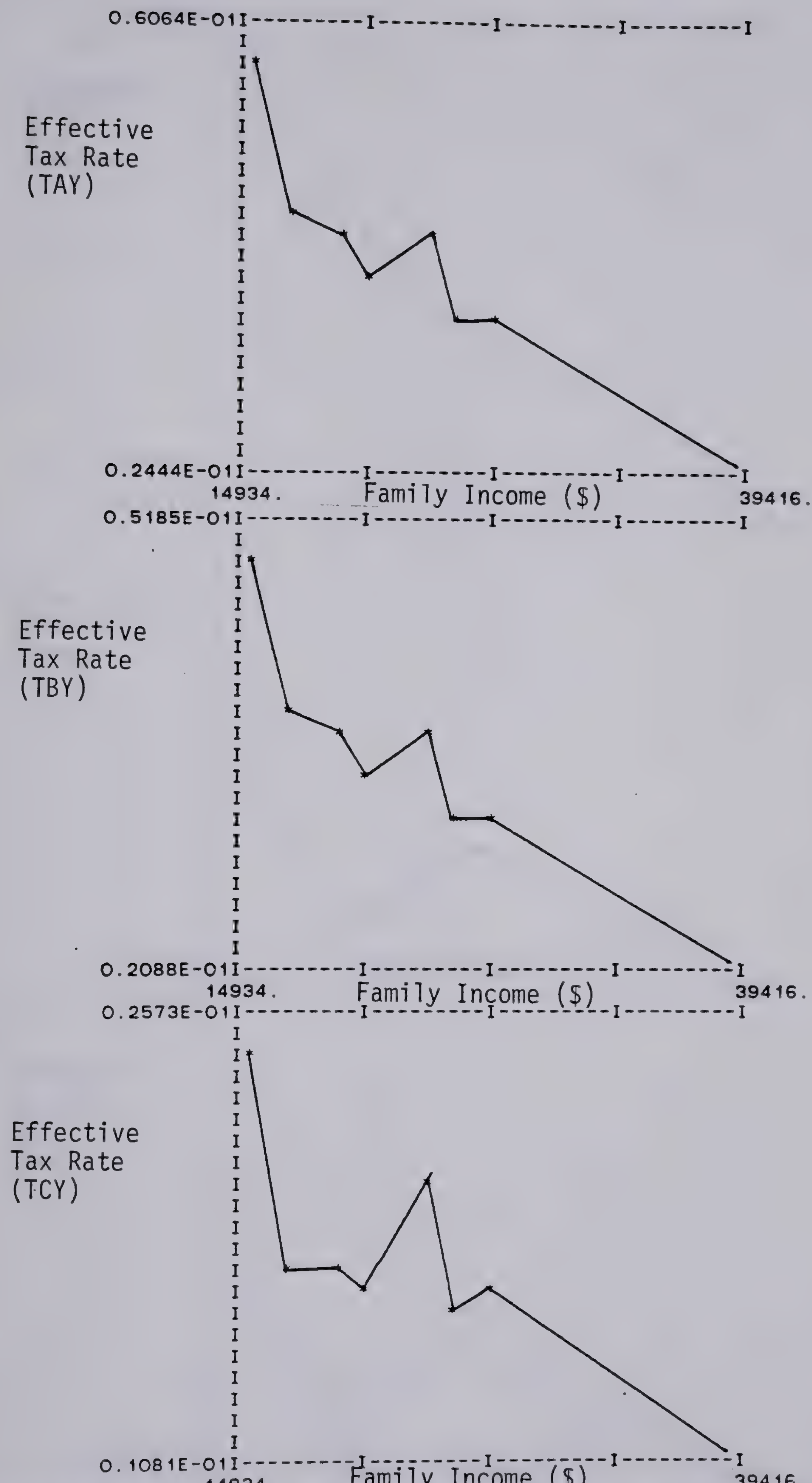


Figure K.4 THE DISTRIBUTION OF TAX BURDENS BY FAMILY INCOME CLASS

(Effective Tax Rates – King-Reinhard II)

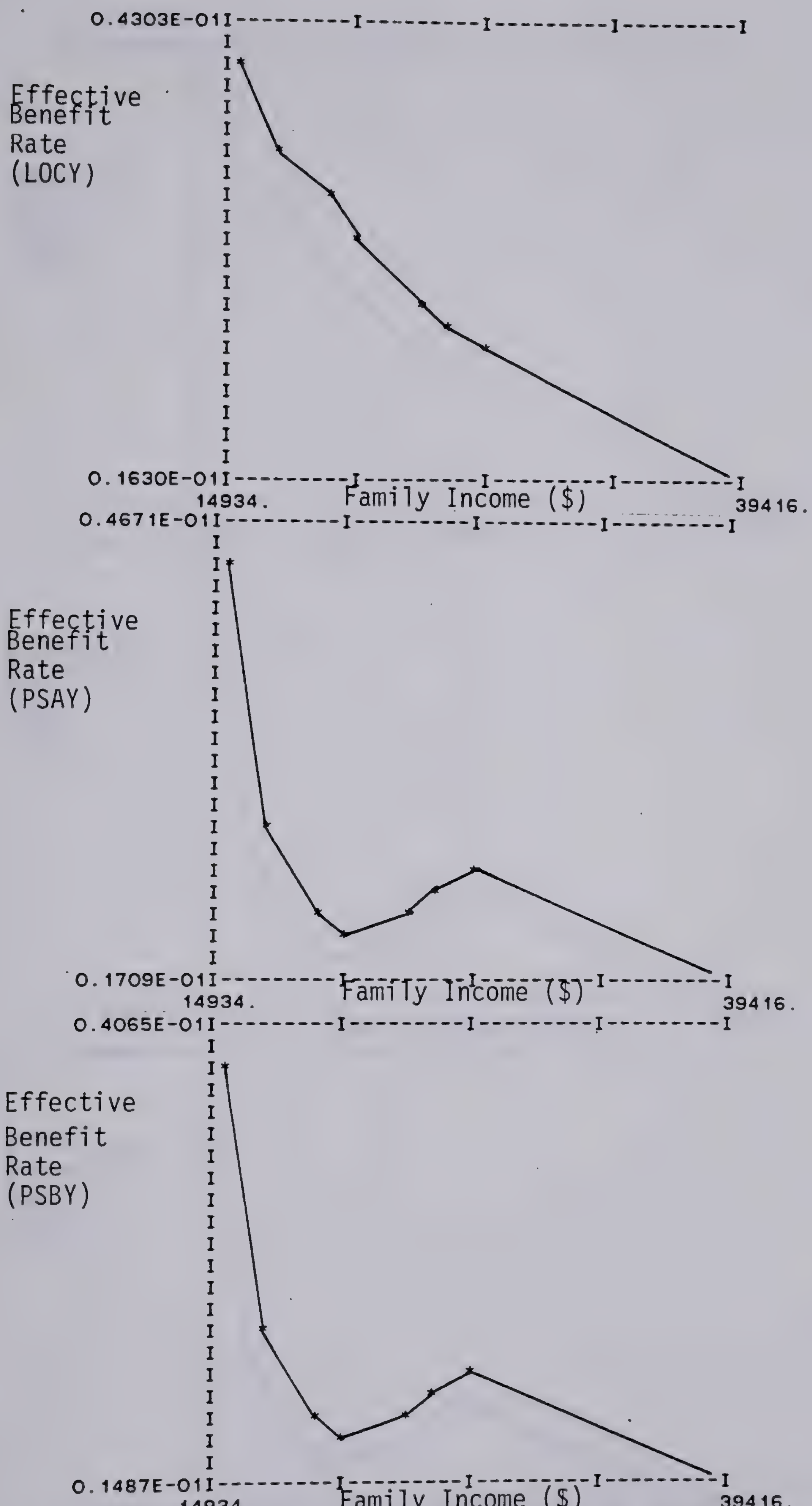


Figure K.5 THE DISTRIBUTION OF LOCAL PUBLIC SECTOR BENEFITS BY FAMILYINCOME CLASS (Effective Benefit Rates – Oates I)

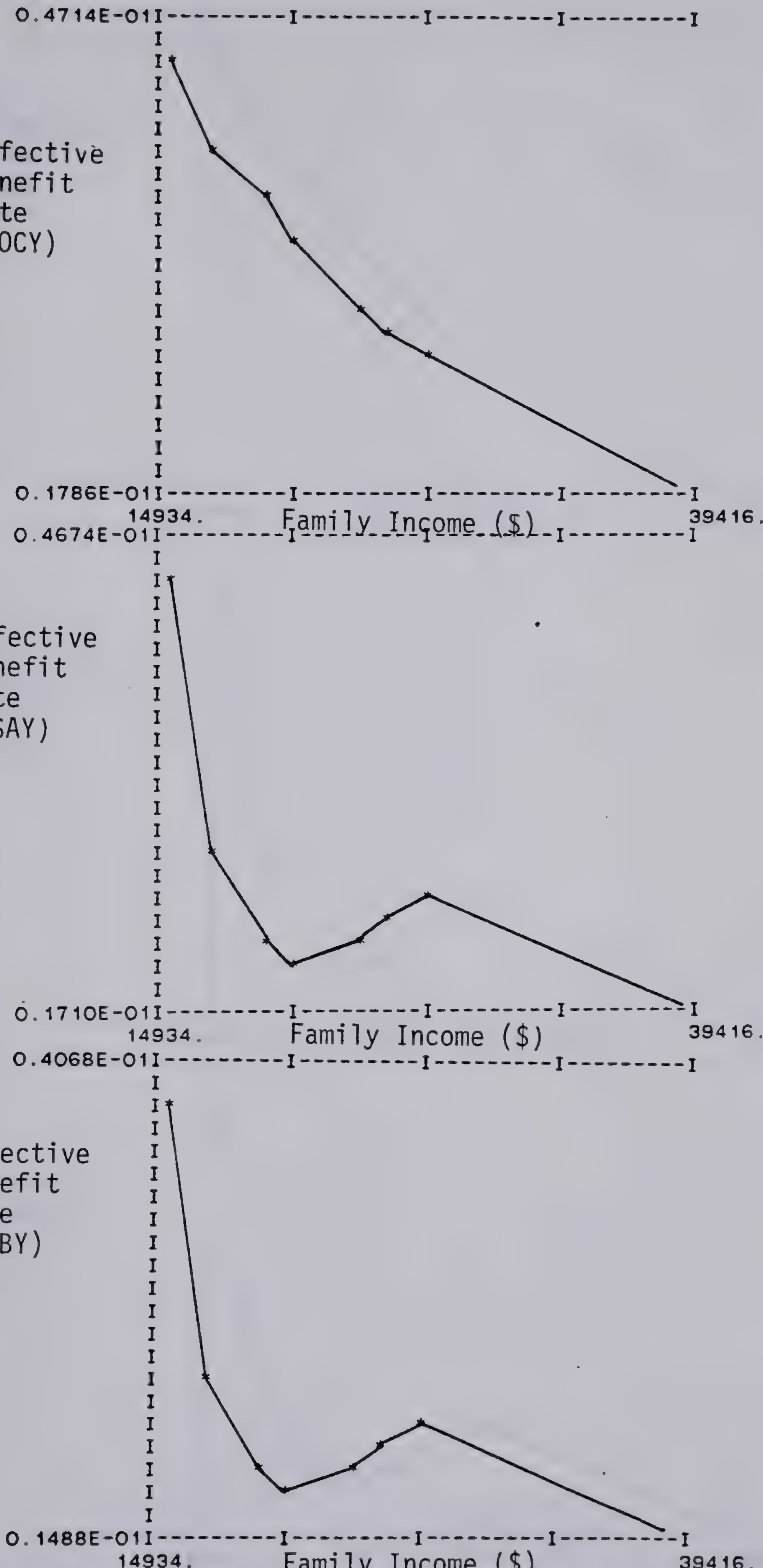
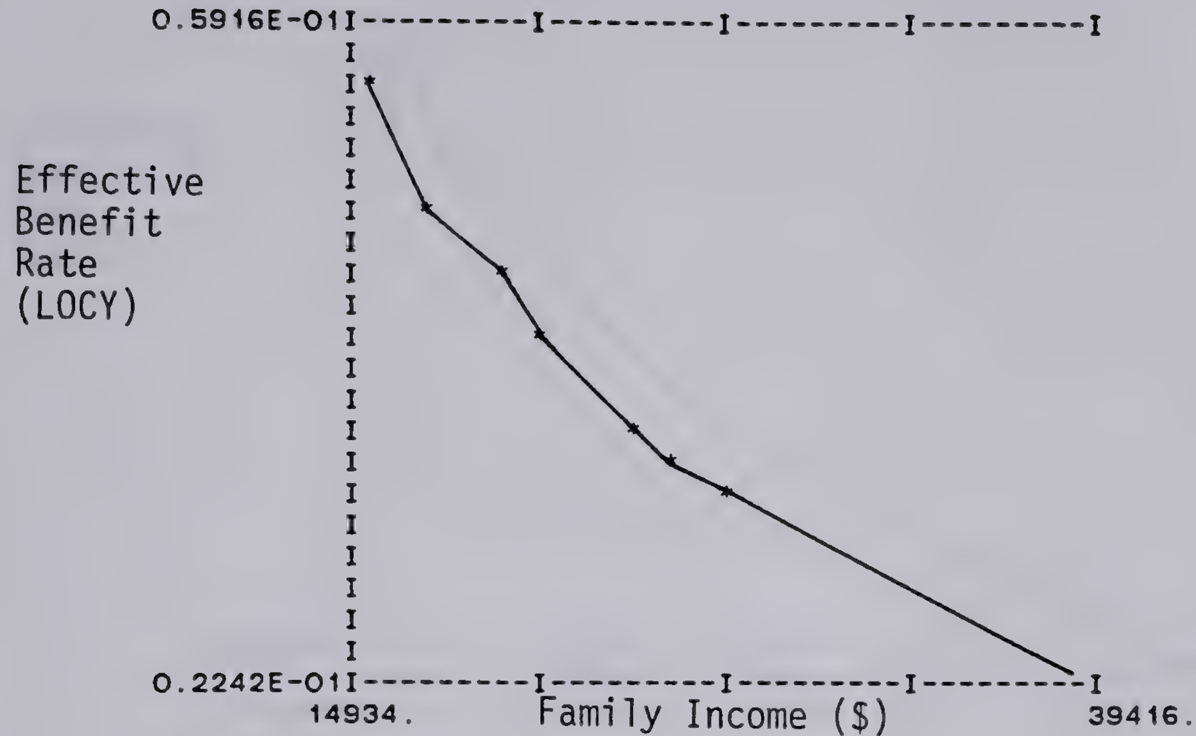
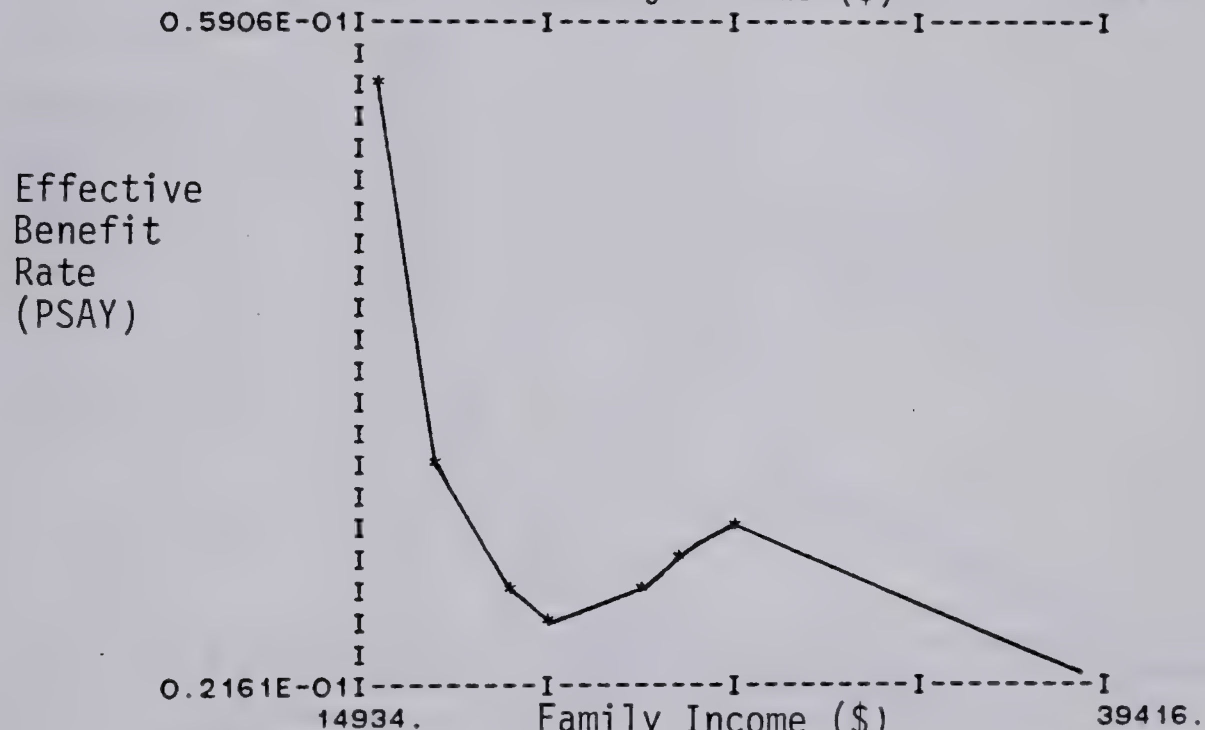


Figure K.6 THE DISTRIBUTION OF LOCAL PUBLIC SECTOR BENEFITS BY FAMILYINCOME CLASS (Effective Benefit Rates – Oates II)





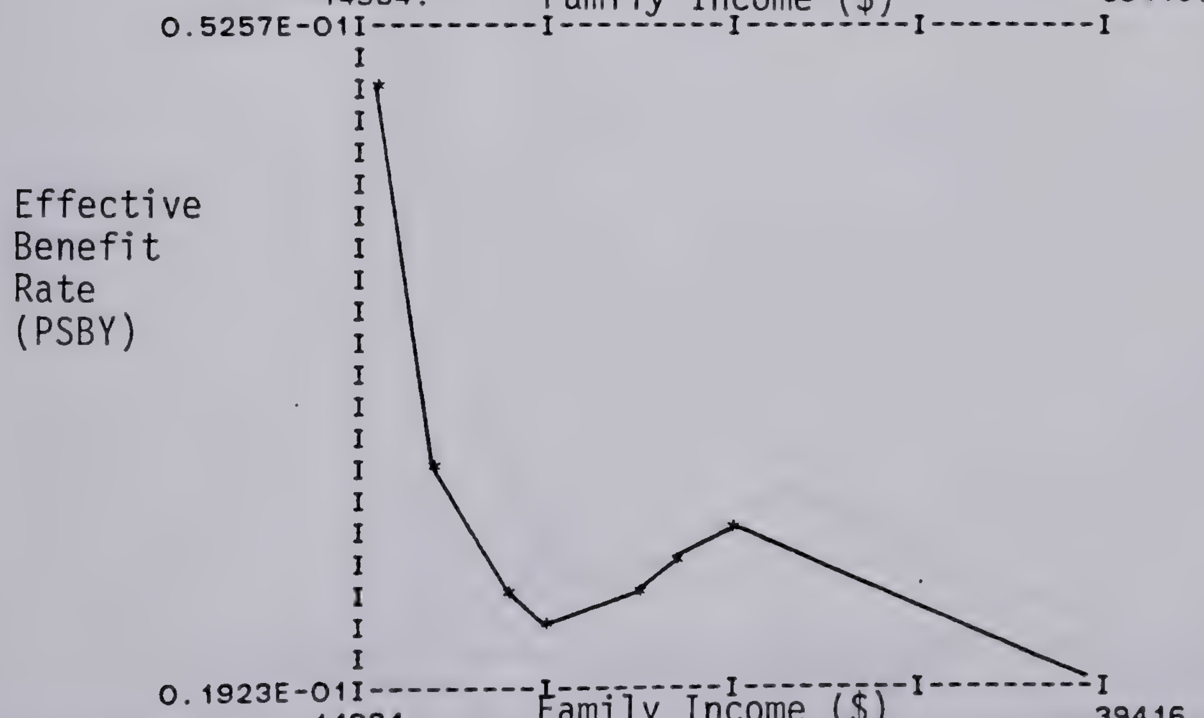


Figure K.7 THE DISTRIBUTION OF LOCAL PUBLIC SECTOR BENEFITS BY FAMILYINCOME CLASS (Effective Benefit Rates – King–Reinhard I)

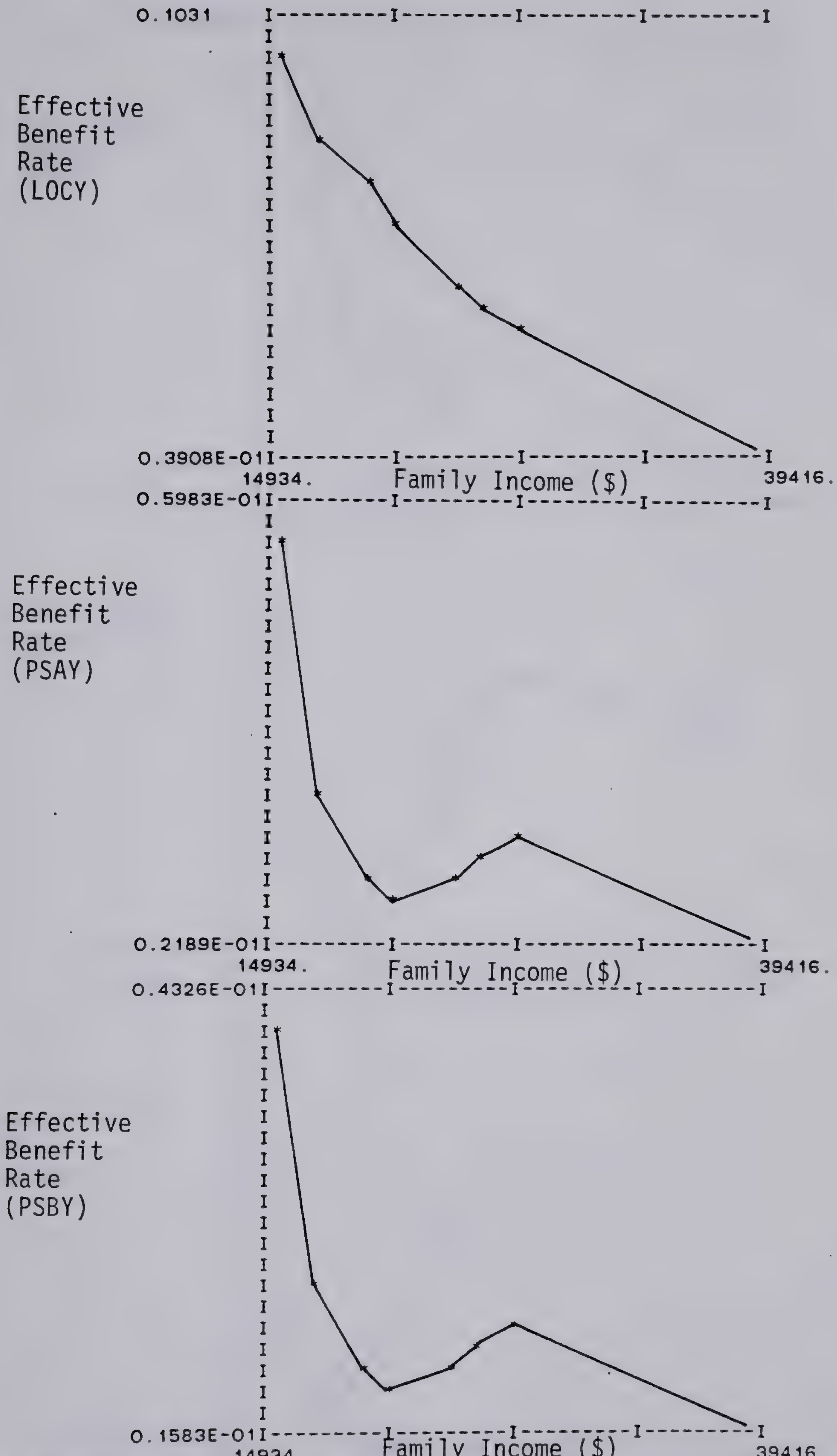


Figure K.8 THE DISTRIBUTION OF LOCAL PUBLIC SECTOR BENEFITS BY FAMILYINCOME CLASS (Effective Benefit Rates – King–Reinhard II)

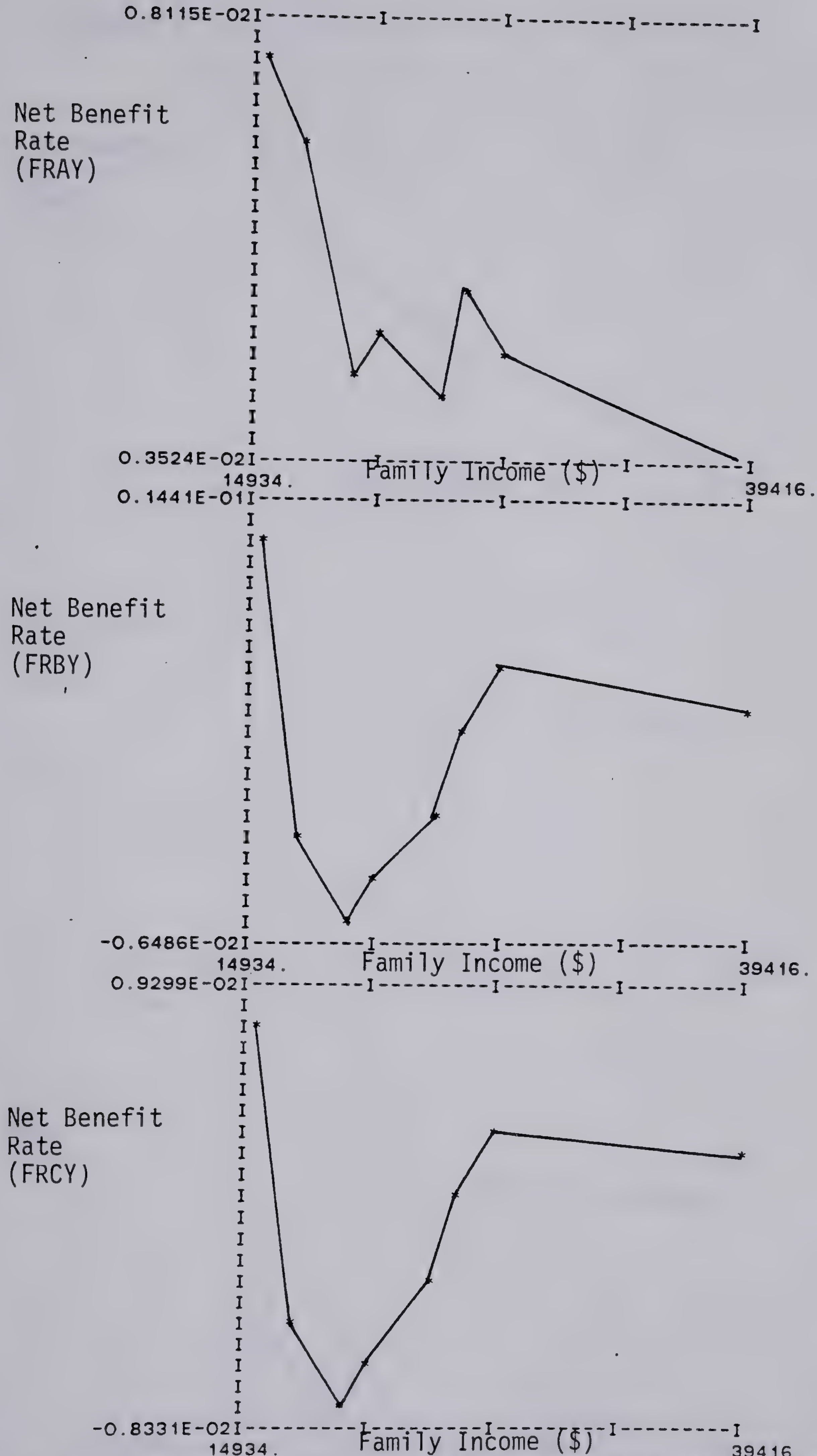


Figure K.9 EFFECTIVE RATES OF NET FISCAL INCIDENCE BY FAMILY INCOME CLASS

(Oates I)

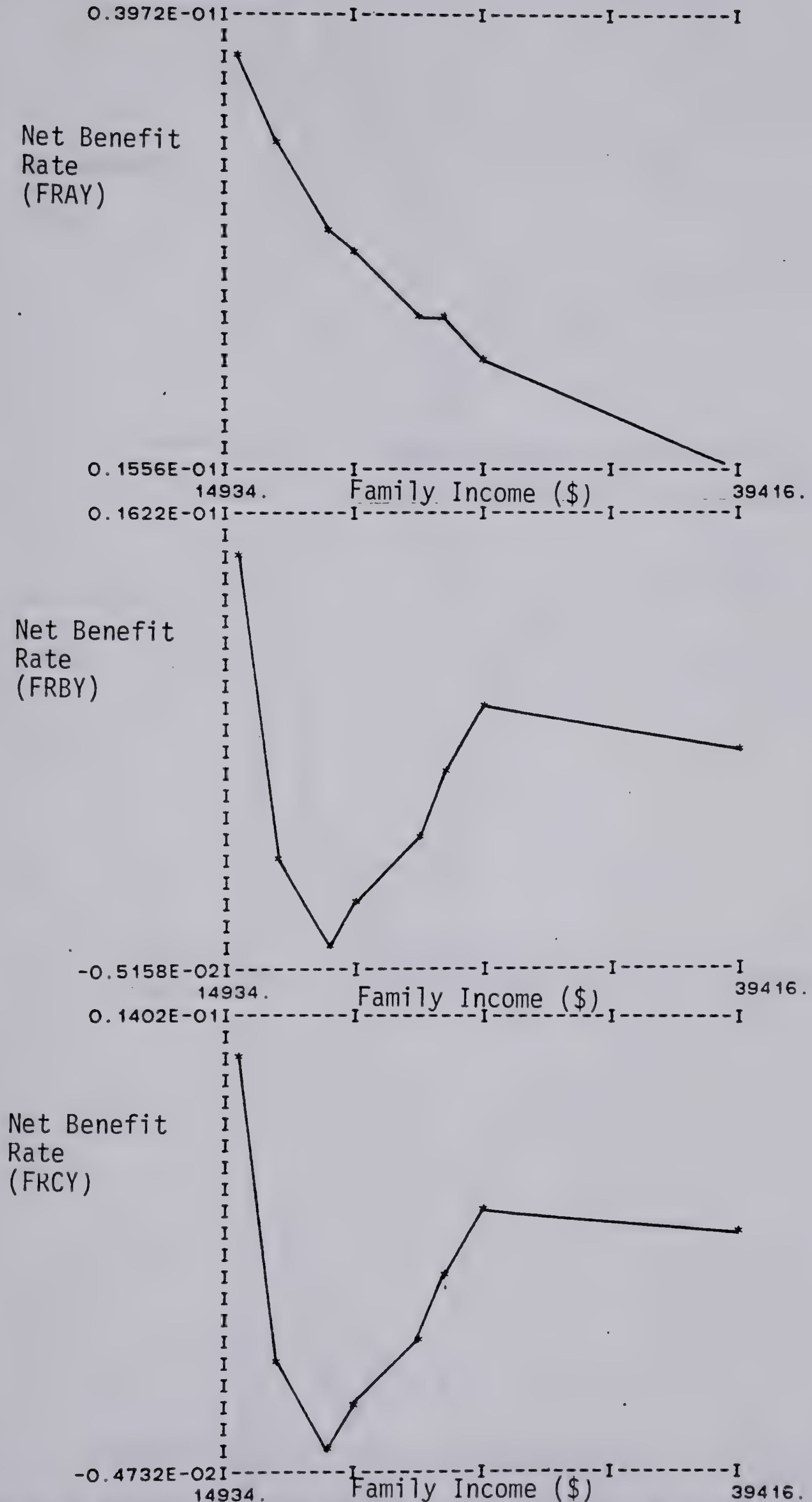


Figure K.10 EFFECTIVE RATES OF NET FISCAL INCIDENCE BY FAMILY INCOME CLASS

(Oates II)

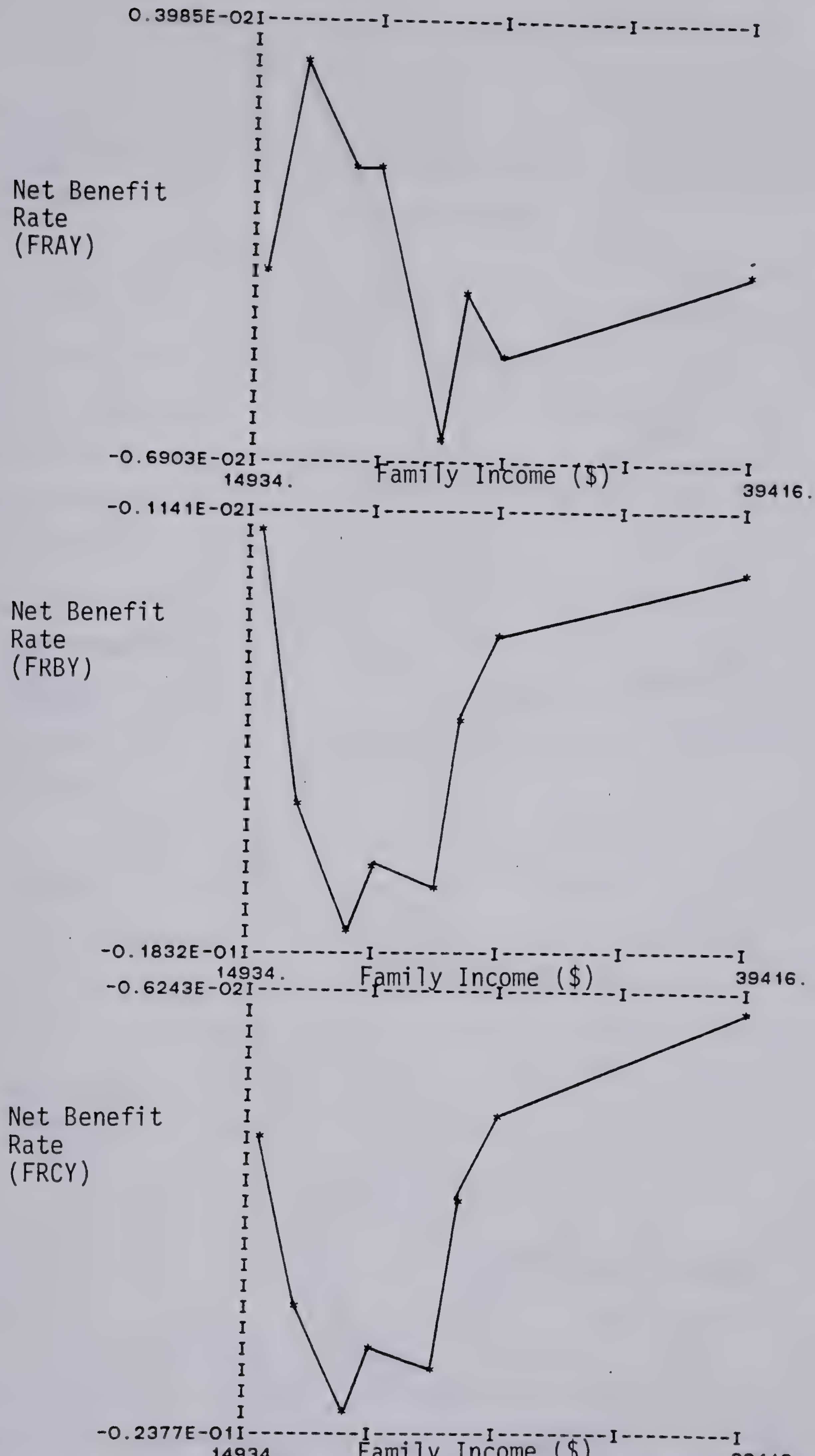


Figure K.11 EFFECTIVE RATES OF NET FISCAL INCIDENCE BY FAMILY INCOME CLASS

(King–Reinhard I)

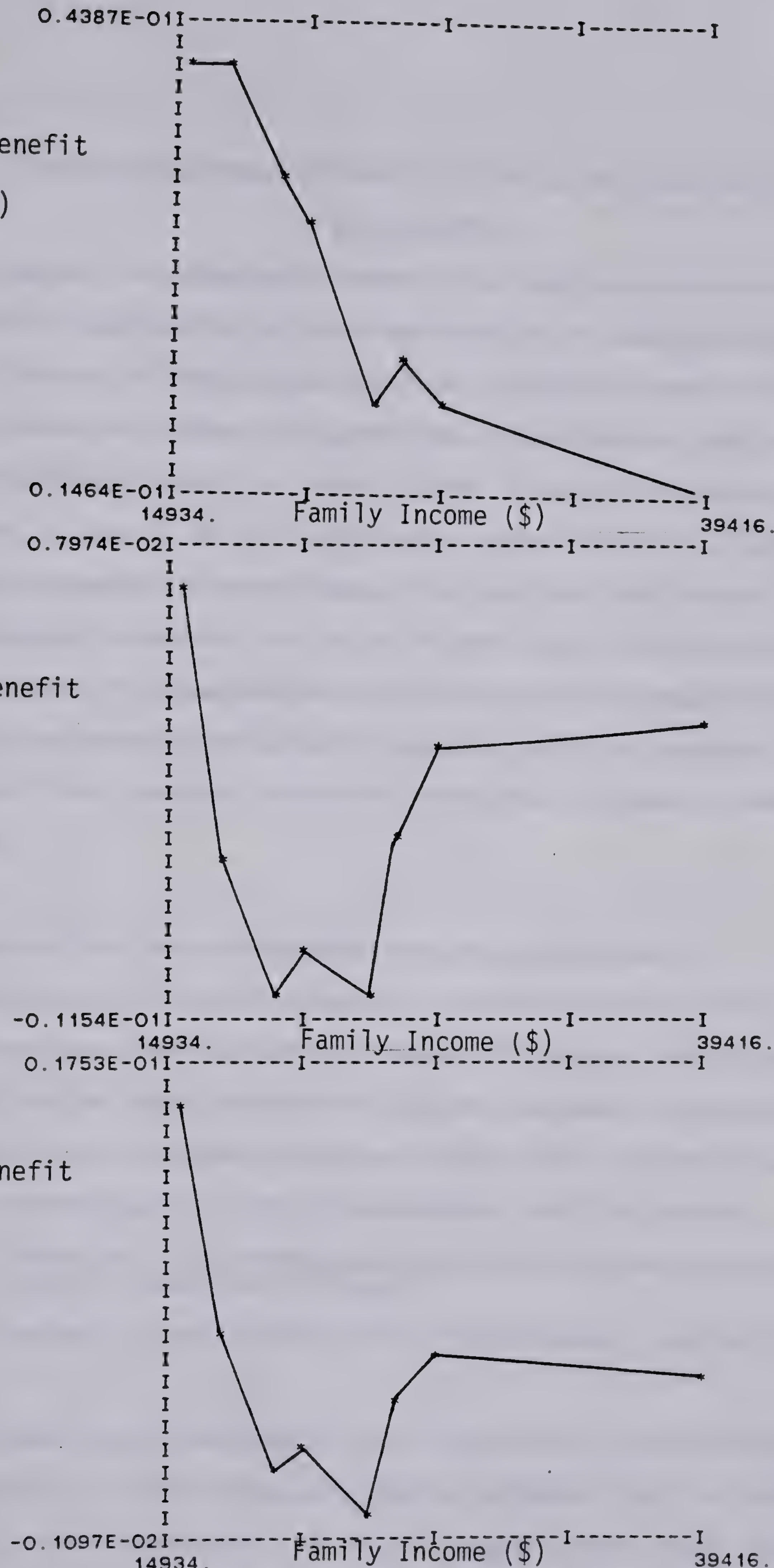


Figure K.12 EFFECTIVE RATES OF NET FISCAL INCIDENCE BY FAMILY INCOME CLASS

(King-Reinhard II)

Appendix L

THE NET REDISTRIBUTIVE IMPACT OF THE LOCAL PUBLIC SECTOR IN EDMONTON

In chapter 5 we estimated the impact of the local public sector on family income distribution. We observed that the annualized effect of the change in property values is small with respect to family income for almost all income classes. We now turn our attention to determine if these small gains/losses due to the local public sector translate into any quantifiable impact on family income inequality as measured by the Gini coefficients. A test of the net redistributive impact of the local public sector in Edmonton is carried out in several steps . First, pre-fisc family income (family money income) inequality is quantified with the use of several commonly accepted yardsticks of income inequality. The same measures are then calculated for post-fisc family incomes (adjusted broad income as defined earlier) and the results are compared. The statistical significance of any observed differences among the two sets of measures is also investigated.

Comparison of Pre-Fisc and Post-Fisc Family Income Inequality

The literature on the measurement of income inequality is rich and varied. A survey of the relative merits of alternate measures of inequality is beyond the scope of this chapter and the reader is referred to excellent treatises on the subject by Kakwani (1980), Beach, Card and Flatters (1981) and Cowell (1977).[1] The most commonly used measure of income inequality is the Gini concentration ratio. This measure

> "..is the ratio of the difference between the line of absolute equality and the Lorenz curve" (Sen 1973, p.30).

This index assumes a value of zero for complete equality and one for complete inequality.

We fitted several functional forms to estimate the Lorenz curve and to derive Gini coefficients of income inequality and to statistically test for significance of differences among distributions. The two functional forms which fitted the data remarkably well (R^2 exceeded 0.95) were suggested by Kakwani and Podder (1973).

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[1] See also Love and Wolfson (1976), Reynolds and Smolensky (1977a,1977b) and Alberta Education (1981).

Kakwani and Podder (1973) fitted the following functions to Australian data :

$$1 - \eta = (1 - \Pi)^{\delta} \qquad 0<\delta<1 \tag{L.1}$$

where η is cumulative proportion of income and π is cumulative proportion of households. If $\delta = 1$ the Lorenz curve coincides with the income equality line and if $\delta < 1$ the curve lies below the income equality line. Gini concentration ratio based on this function is defined as follows:

$$G = \frac{1 - \hat{\delta}}{1 + \delta} \tag{L.2}$$

A second function to represent the Lorenz curve was specified by them as follows:

$$\eta = \Pi \, e^{-\beta(1 - \Pi)} \tag{L.3}$$

If $\beta = 0$ the Lorenz curve coincides with the income equality line, and if $\beta > 0$ the curve lies below the income equality line. The Gini coefficient for this function can be computed as follows:

$$G = 1 - \left\{ \frac{2(\beta - 1)}{\beta^2} \right\} - 2\left\{ \frac{e^{-\beta}}{\beta^2} \right\} \tag{L.4}$$

for $\beta>0$. If $\beta = 0$ the Gini ratio equals zero. If $\beta = \infty$ the Gini ratio equals one.

The two functions cited above were estimated using OLS. The estimated values of the parameters δ and β along with their standard errors and the calculated Gini coefficients are reported in Table L.1. The Gini coefficients for pre-fisc family income distribiution and four alternate series of post-fisc family incomes (adjusted broad incomes) are quite close. Four series of post-fisc family incomes used for this purpose were derived as follows:

Post-fisc family income A : It incorporates net fiscal incidence derived from equation 3.14 (Oates I).

Post-fisc family income B: It incorporates net fiscal incidence estimated

Table L.1 GINI CONCENTRATION RATIOS OF PRE AND POST–FISC INCOME DISTRIBUTIONS

INCOME VARIABLE	COEFFICIENT ESTIMATE[a]	STANDARD ERROR	GINI CONCENTRATION RATIO
PRE-FISC INCOME	δ = 0.5478	0.04608	0.2921
	β = 1.1906	0.41248	0.3022
POST-FISC INCOMES:			
A	δ = 0.5467	0.04631	0.2930
	β = 1.2302	0.40702	0.3096
B	δ = 0.5468	0.04631	0.2929
	β = 1.2296	0.40689	0.3095
C	δ = 0.5470	0.04618	0.2928
	β = 1.2198	0.40742	0.3076
D	δ = 0.5476	0.04628	0.2923
	β = 1.2260	0.40525	0.3087

a: The coefficients are statistically significant at .05 level and R^2 exceeds 0.95 in all cases.

from equation 4.43 (King–Reinhard II).

Post-fisc family income C: It is based on a net fiscal incidence derived from equations 3.14 using the approach described in chapter 5, section 5.5.

Post-fisc family income D : It uses the net fiscal incidence estimated from equation 4.43 using the approach described in chapter 5, section 5.5.

The Gini coefficients for all four cases of post–fisc incomes are slightly higher than the one obtained for the pre–fisc income. This implies that although the redistributional influences of the local public sector are minor yet they do aggravate income inequality. Pre–fisc and post–fisc family incomes are also represented by Lorenz curves in Figures L.1, L.2 and L.3. Any alterations in the distribution of family incomes by the local public sector are hardly discernible from these graphs.

Tests of Equality of Gini Coefficients

Comparison among Gini coefficients so far were based on informal statements such as one set of coefficients are "quite close" to another set. Now we consider a more rigorous test of the equality of Gini coefficients for pre–fisc and post–fisc income distributions.

We hypothesize that :

$$\hat{\beta}_y = \hat{\beta}_{ABYA} = \hat{\beta}_{ABYB} = \hat{\beta}_{ABYC} = \hat{\beta}_{ABYD} = \bar{\beta}$$

$$\text{also } \hat{\delta}_y = \hat{\delta}_{ABYA} = \hat{\delta}_{ABYB} = \hat{\delta}_{ABYC} = \hat{\delta}_{ABYD} = \bar{\delta}$$

where Y is pre–fisc family income and ABYA, ABYB, ABYC and ABYD are the four series of post–fisc family incomes.

The above hypotheses can be tested with the help of a Chow test [2]

Step I: Combine the observations for pre–fisc and post–fisc income distributions and run a pooled regression and obtain the residual sum of squares (RSS) say S_1 with $N_1 + N_2 - k$ degrees of freedom.

Step II: Run individual regressions and obtain their RSS say S_2 and S_3 for the two income distributions. Add S_2 and S_3 to obtain S_4 with

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[2] See Gujarati (1978),pp.306–307.

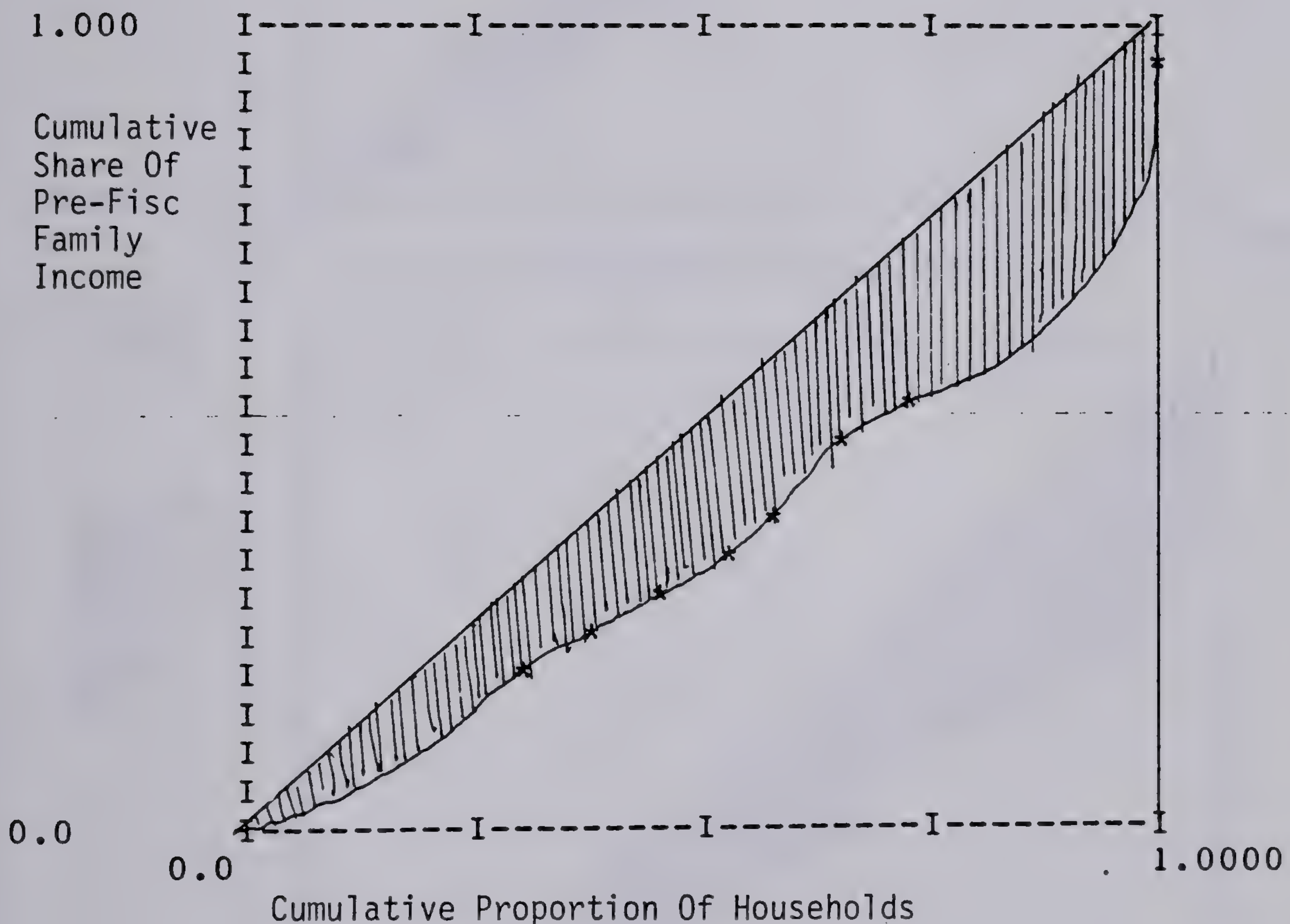
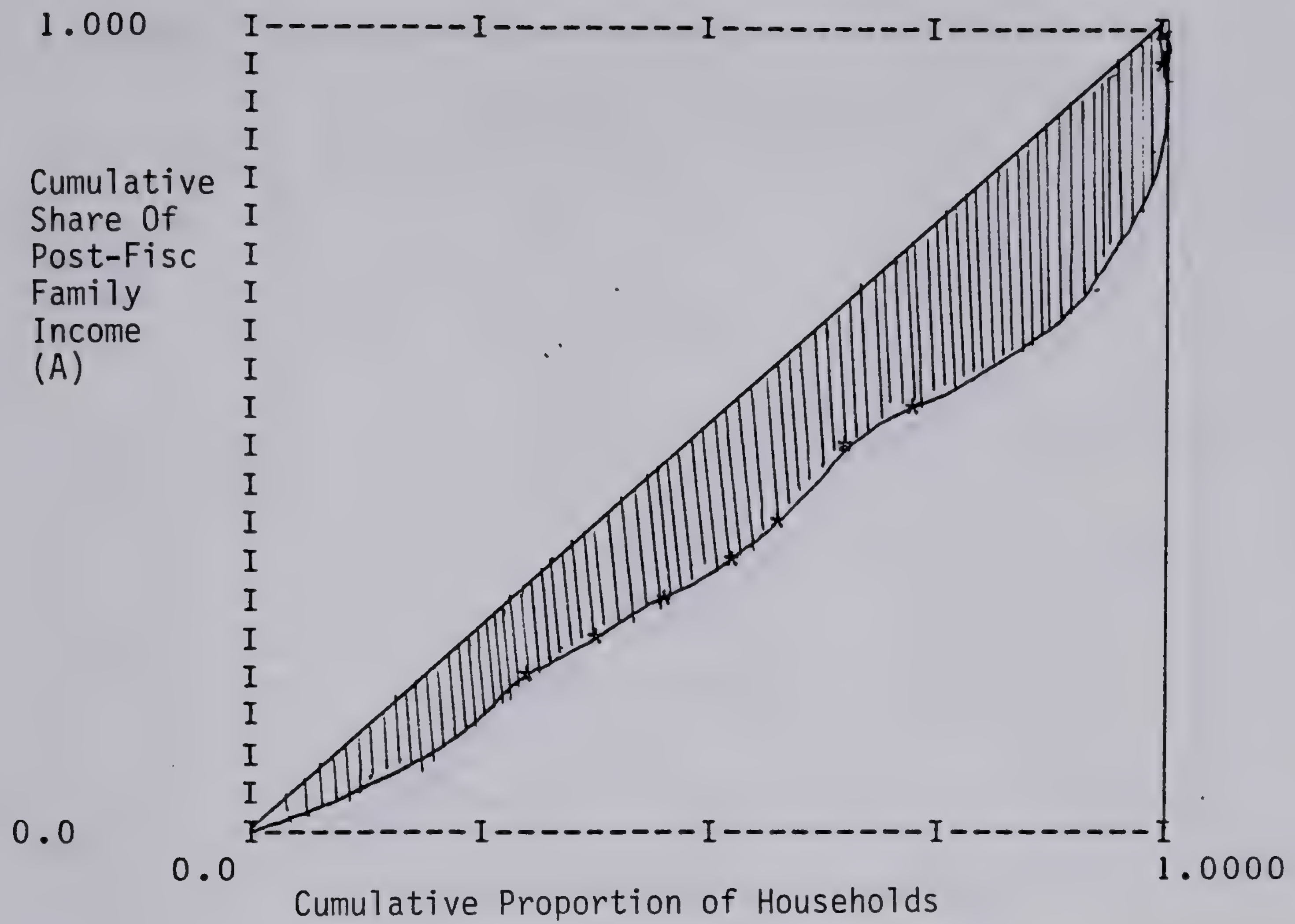


Figure L.1 LORENZ CURVE OF PRE-FISC FAMILY INCOME DISTRIBUTION



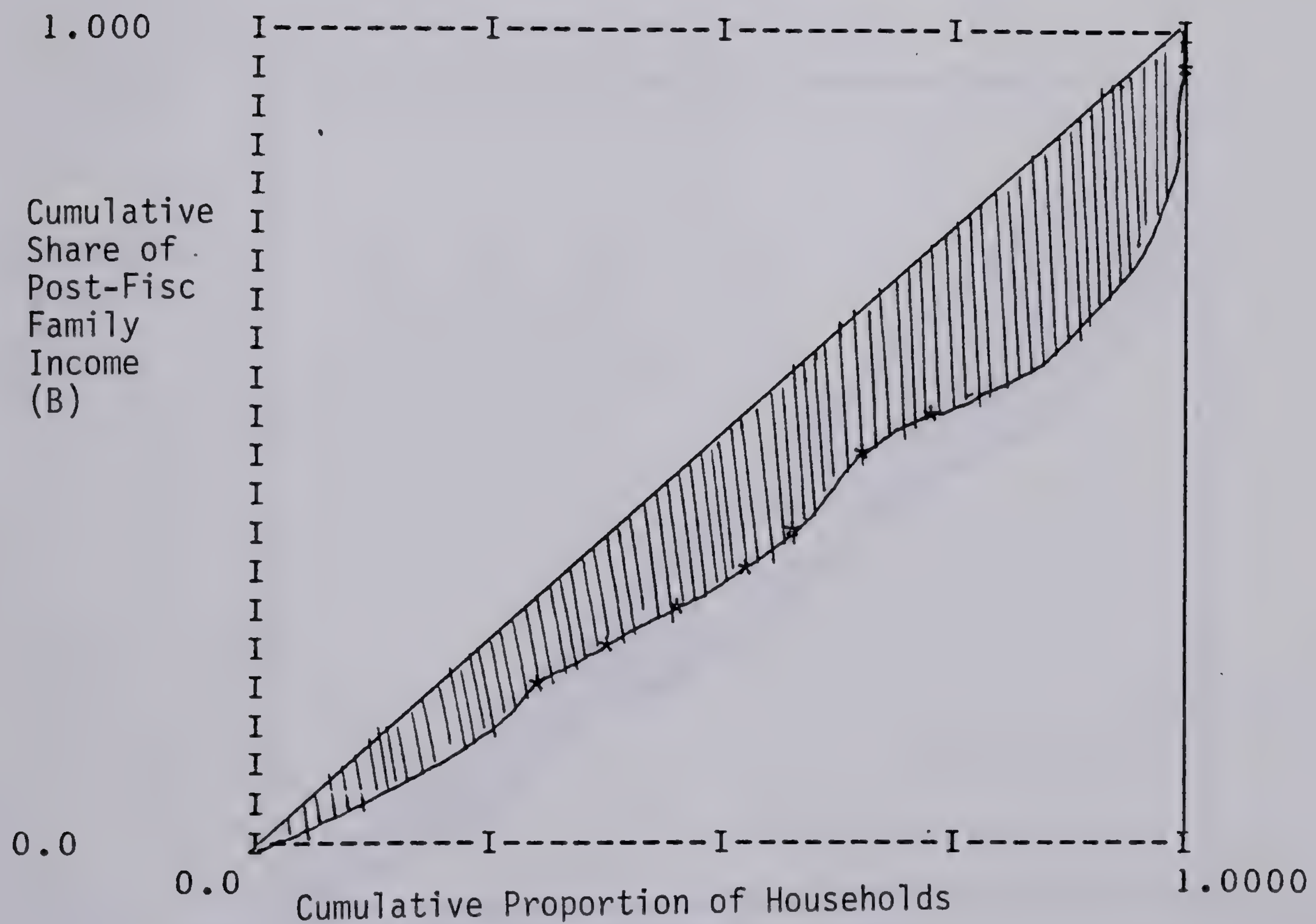
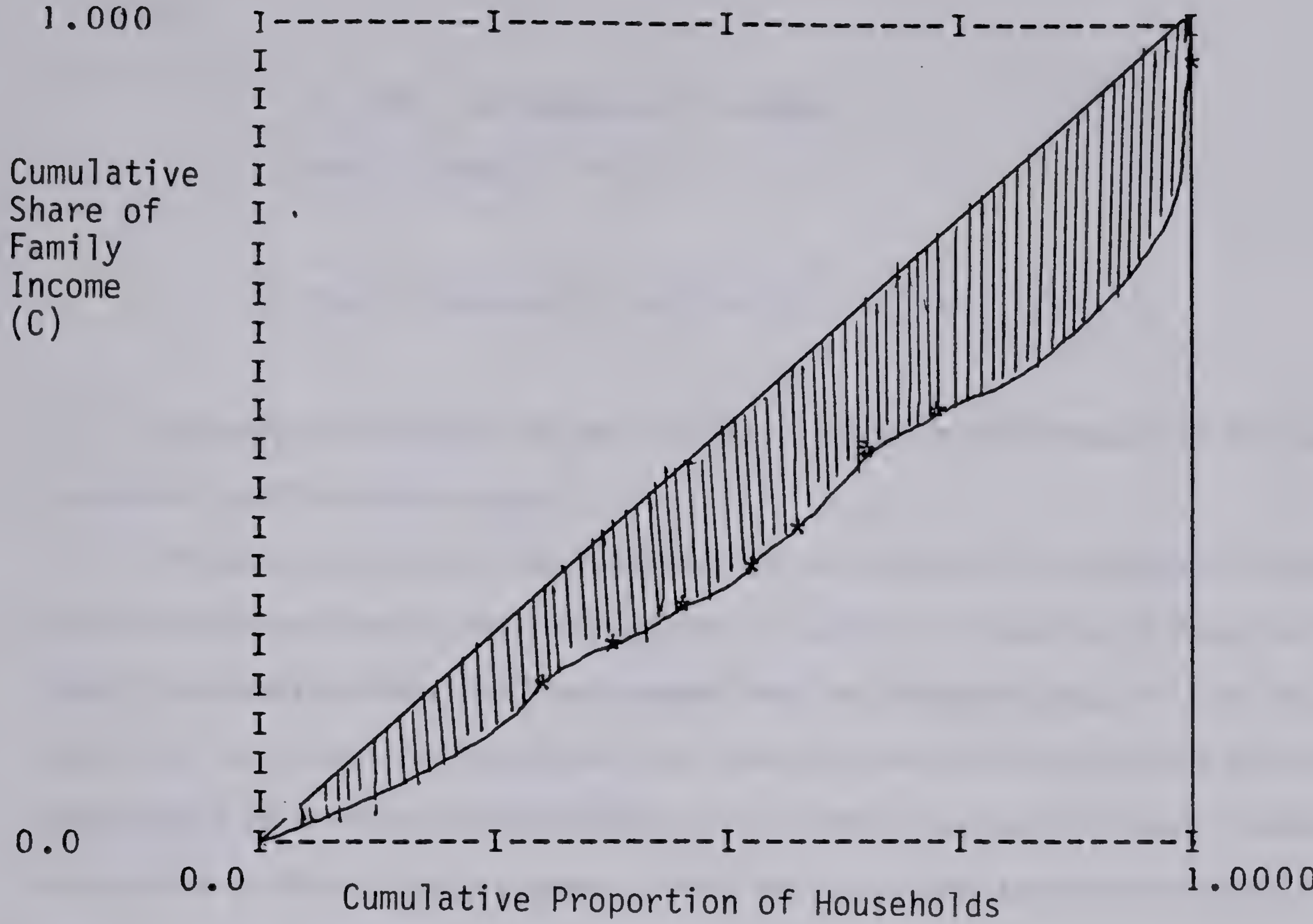


Figure L.2 LORENZ CURVES OF POST-FISC FAMILY INCOME DISTRIBUTION

(A & B)



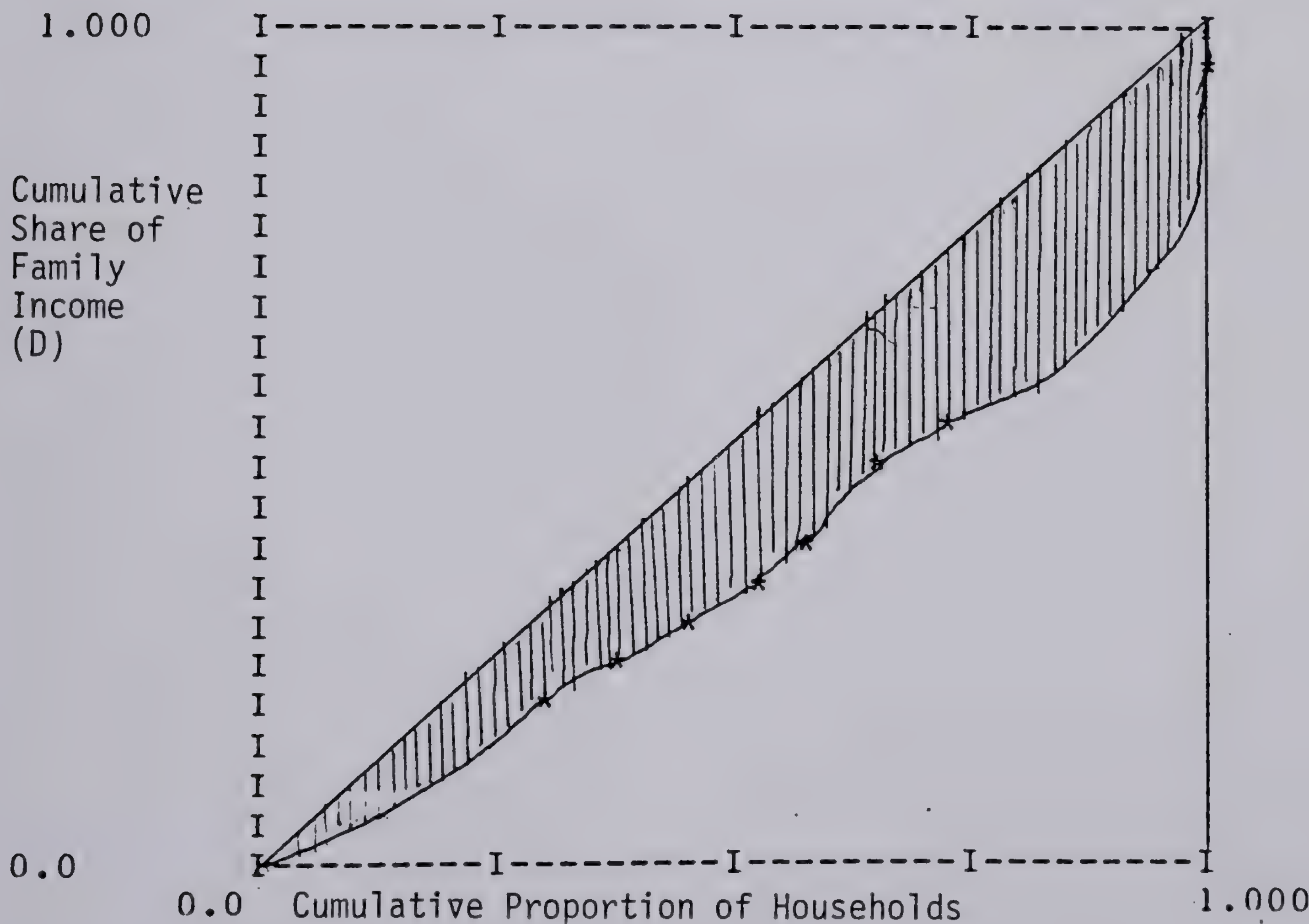


Figure L.3 LORENZ CURVES OF POST-FISC FAMILY INCOME DISTRIBUTION (C & D)

$N_1 + N_2 - 2k$ degrees of freedom.

Step III: Obtain $S_5 = S_1 - S_4$

Step IV: Compute $F_0 = (S_5 / k)/(S_4 / (N_1 + N_2 - 2k))$

If F_0 exceeds the critical F at say .05 level reject the hypothesis that the pair of regression coefficients are equal.

The above procedure was followed for pairs of pre-fisc and post-fisc family incomes discussed earlier and the calculated F values are presented in Table L.2. In all cases the calculated values of F are smaller than the tabulated values of F at .05 level. Therefore, we reject the hypothesis that there are statistically significant differences among Gini's for pre-fisc and post-fisc family incomes. This result, however, comes as a no surprise as the net fiscal incidence under most allocation basis comes close to one percent of family incomes.

Table L.2 CALCULATED F VALUES OF CHOW TESTS FOR THE EQUALITY OF COEFFICIENTS OF β's and δ's.

	F - RATIOS FOR	
	(β) Coefficients	(δ) Coefficients
Pre-fisc family income and		
(i) post fisc - family income A	.0504	.028
(ii) " " " " B	.0519	.001
(iii) " " " " C	.0360	.001
(iv) " " " " D	.0460	.003
Tabulated values of F at .05 level of significance.	3.49	3.74

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